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The ABB Executive Committee decided to launch a project in order improve the low performance of customer deliveries. This was part of the strategic initiatives at ABB and in accordance with the agenda of the executive committee at ABB, which monitors the Relentless Execution Dashboard of key performance indicators. As one operational key performance indicator request on-time delivery is part of the dashboard.

The goal of the thesis was to get a clearer picture of ABB's delivery performance from a customer point of view as opposed to the factory perspective, which was the focus of historical internal on-time delivery measures.

The main objective of this study was to find and analyze the root causes of big variation and hence bad performance in request on-time delivery, to create an improvement plan and implement the improvement actions to the ABB processes in order to improve the request on-time delivery performance.

The scope of the thesis applies to DM Division, Business Unit Robotics and Product Group 4314 which represents Robots and applications in Italy.

The theoretical framework of the study focused on two theories – on time delivery theory and lean methodology as a leading theory. The study was performed using lean methodology and tools systematically. The process used in the study is called DMAIC (Define, Measure, Analyze, Improve and Control) which supports a systematic lean way of running and performing an improvement projects in a large scale.

The study showed that by running a lean project with a highly specified scope it is possible to achieve better request on time delivery performance within a year.

Keywords	Lean methodology, Relentless Execution Dashboard, DMAIC, on-time delivery, ROTD, variation, project, theoretical framework

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ABB johto päätti alkaa mittaamaan asiakastyytyväisyyttä toimitusvarmuuden osalta. Tämä uusi mittari mittaa asiakkaan pyytämää toimituspäivää todelliseen saapumispäivämäärään ottaen huomioon toimitusehdot, joita tilauksessa käytetty.

Tämä mittari on osa ABB tasoista avainmittaristoa ja lukujen syöttäminen järjestelmään on pakollista kaikissa ABB maissa ja paikallisyhtiöissä, joissa myyntiä on edellisen kuukauden aikana tapahtunut.

Tämän tutkimuksen tarkoitus on kartoittaa niitä syitä, jotka ovat johtaneen italiassa erittäin huonoon toimitusvarmuuden käyttämällä lean metodologian prosessia ja menetelmiä. Työ kohdentyy vain yhteen tulosyksikköön italiassa, PG 4314 eikä sisällä sisäisiä toimituksia.

Tutkimus perustuu DMAIC prosessin käyttöön, jossa on viisi dimensiota, määrittely, mittaus, analyysi, parannus ja kontrolli. Tämän teorian avulla näytän toteen mitkä ovat ne juurisyyt, joista huono ROTD prosentti johtuu ja mitä toimenpiteitä on tehtävä, jotta toimitusvarmuus paranee.

Avainsanat	“lean” metodologia, DMAIC, toimitusvarmuus, asiakastyytyväisyys, juurisyy, projekti, prosessi, menetelmä, avainmittaristo

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1 Thesis Description

The ABB Executive Committee has decided to create a Relentless Execution Dashboard, which comprises critical Key Performance Indicators to measure operational performance. Measuring On-Time Delivery against the delivery date requested by the customer is included as a key metric within the dashboard. The idea behind the KPI is to get a clearer picture of ABB's delivery performance from a customer point of view as opposed to the factory perspective, which was the focus of historical internal OTD (on-time delivery) measures. Within DM (Discrete automation and motion) Division the management decided to measure separately the delivery date versus the promised and also against the requested date.

1.1 Background and Aim of the Study

NPS is an abbreviation of Net Promotor Score, based on feedback from ABB customer. NPS scores and red card feedback indicate on-time deliveries and lead times as frequent issues. At the same time the existing internal ex-works OTD suggest high performance (Figure 01).

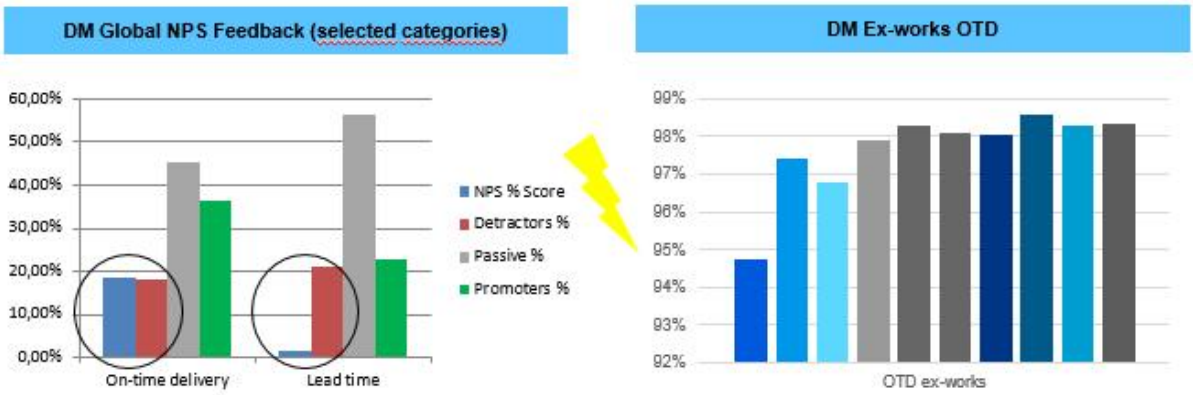


Figure 01. Net Promotor Score 2015 and DM Ex-words OTD (ABB intranet).

Therefore, ABB's Executive Committee decided to run an initiative to get improve the customer satisfaction by improving the request on time delivery performance.

ROTD-related (Request on-time delivery) red cards are consistently highest for both NPS (Net Promoter score, scored by ABB customers) and ITPS (Internal Transactional Partnership Survey, scored by internal customers) making ROTD the number one contributor to poor customer satisfaction within DM (Figure 02).

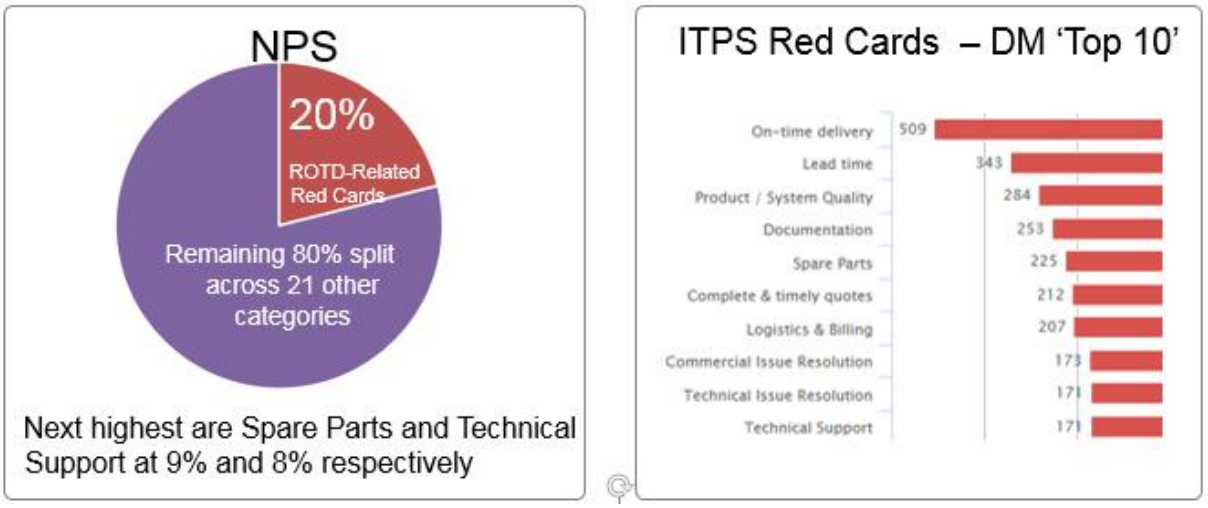


Figure 02. ABB Net Promoter Score Dashboard data (ABB intranet)

1.2 Research question

Research question in this study is Questions to be answered to reach the goal of the thesis:

What improvement actions need to be taken to improve the ROTD performance for Robotics Product Group 4314 (Robots and applications) in Italy?

1.3 Motivation

ABB has very low delivery performance to 3rd party customers and therefore issues need to be identified and improvement activities executed throughout the organization. I work for DM Division, in Operations and Excellence team. My responsibility in the company is to run and roll-out improvement projects in ABB DM major countries.

In this project my role was to act as a *Global Project Manager*, to manage the project and implement the decided improvement activities with a team from organization units involved.

1.4 Objectives

The main objective is to find and analyze the problem areas in customer on-time deliveries based on key performance indicator, further study the reasons behind and to create and transform **improvement plan** to overcome those problems. Objective is to increase the DMRO on-time delivery performance from 30% up to 60% during 2016.

1.5 Scope

The scope of the thesis applies to DM Division, Business Unit Robotics and Product Group 4314 which represents Robots and applications. Thesis covers deliveries from local warehouse as well as direct shipments from supplying plants in Sweden and China to Italian local market. Study takes into account the incoterms agreed with the end customer.

The study is based on the lean methodology and on-time delivery (OTD) theories.

Research is based on current state analysis which is taken from the current systems showing the poor ROTD performance as a starting point as well as on the author's own analysis, based on lean methodology.

As a result of the study the issues found are corrected and results shown as better ROTD performance for PG 4314 in Italy. Comparison is done between January 2016 and September 2016.

1.6 Out of scope

The study will **not** cover any of the following areas:

- Related processes
- Invoicing process
- OMS delivery process (not applicable for DMRO)

- The analyzes OTD from factories as this is already in place

- The analyzes the performance of each segment of the value chain (only customer wished date versus actual delivery date)
- Internal order on-time delivery performance

2 Data sources and methodology

In the following chapters methods and tools used in the study are defined.

2.1 Data collection methods and tools

The starting point of data analysis was from company official Key performance indicator Dashboard as of January 2016 as explain in Chapter 1 – limiting the scope to cover ABB Italy, product group 4314.

In order to collect the necessary data for this theses, different sources had to be considered:

LSU SAP ERP: The local SAP system was the data source for orders. Product-related data were captured in the Sales and distribution module, project related data in the Project Execution module

Prodution Unit data: Data related to direct deliveries from factories to end customers shere provided by the SU

Local Business Intelligence (BI) Platforms: In some countries, local BI data warehouses may exist and serve as data hubs, including orderline-level delivery information. In such cases, this data can be used for the KPI calculation. This was not the case in Italy.

In this study the local ERP was selected as main data source, supported by the supplying plant in case of drop shipment to end customer.

In the local ERP system in Italy the key nominators were

- Sales order line item data
- Item category
- Supplying plant (including local warehouse in Italy)
- Customer wished delivery date per sales order line
- Actual delivery date per sales order line
- Incoterm used per order

Transport times for statistical calculation when actual date was not available

Request OTD data set for this study all together was:

- total number of sales order lines approx. 1000
- total number of variables = 56
- incoterms used = 5
- supplying plants = 5 + local delivery from italian stock

2.2. Research methodology

The type of the study is an exploratory study to understand and describe the problem. Data collection method is historical data which I is used to measure the current state and find and transform ways to business in order to improve the process to meet the desired state. The research is both quantative by nature, based on the system data, and qualitative using individuals as the source. Research is based on the selected two theories described in Chapter 5.

3 Request on-time Description and Definition

The following chapters describe the ROTD description and definition in detail. Furthermore, it explaines the concept how ABB measures ROTD performance within all divisions.

3.1. General description and definition

The Request OTD Initiative is measured as follows:

A delivery to a customer will be regarded as delivered on time, if the actual delivery date is within the window of –any/+0 days compared to the originally first requested delivery date by the customer.

The first requested delivery date is based on the request made in either a Request for Proposal (RFP) or, and only if no date has been specified in the RFP or no RFP is available, as stated in the Purchase Order or Contract or any other document used in internal trade only, that documents the requested delivery date. Changes of delivery dates are valid only if initiated by the customer and are not allowed in any other case.
INCOTERM Rules shall apply, i.e. the actual delivery date shall be recorded accordingly (EXW, CFP, DDU, DDP, etc.).

In case a customer requested a delivery date of less than 3 days, if no date has been specifically requested or if the requested delivery date is in the past, a standard lead time of 3 days or as published in ABB Products for the specific product shall be used as the basis for calculating the Requested Delivery Date.

ROTD is measured on a monthly basis, targets are set and compared on a **rolling 12** month average.

Formula:

ROTD: $\frac{\#\ of\ orderlines\ delivered\ earlier\ or\ on\ requested\ delivery\ date\ within\ reporting\ perid}{\#\ of\ orderlines\ with\ requested\ delivery\ date\ within\ reporting\ period}$

This KPI (1) is measured on monthly basis for deliveries to **3rd party customers only** i.e. deliveries to other ABB business units were not in scope.

3.2. Product deliveries

Product deliveries are counted on order line level as per the definition above.

Partial deliveries: The last partial delivery date that completes the order line is relevant for the KPI calculation. There is no distinction between partial deliveries agreed/not agreed with the customer

Requested Delivery Date	Date of original requested delivery according to agreed incoterms. This date should be captured before and independent of ABB's confirmed delivery date. If the customer is not specifically asked for a requested date during the order progress (e.g. in case of electronic ordering or standard lead times), ABB's confirmation date is taken as requested date. The date can be updated only if the customer requests a new delivery date after the initial order placement.
Confirmed Delivery Date	ABB's initial confirmed delivery date to customer. The date can be updated only if the customer requests a new delivery date after the initial order placement or the content of the order is changed by the customer. If ABB issues a new confirmed date due to ABB-internal reasons, the 1st confirmation is still relevant for this KPI.
Shipping date	Date when the goods were handed over from ABB to the freight forwarder for delivery to customer (ex-works date)
Delivery date	Option A (preferred, if actual delivery date is available): Actual delivery date in line with Incoterms as reported by the freight forwarder
	Option B (back-up): ABB shipping date + standard transportation lead time for respective delivery postal code and transport mode
Order Line	Sales order line item. Each order line is relevant for the KPI calculation and weighted equally

3.3. Project deliveries

Project deliveries are sales orders, which require ABB to perform additional services in addition to delivery of products. Such services may include installations, on-site testing and training etc.

Within a project context no distinction is made between order lines or individual milestones of a project. *The final completion of the project counts as one record for the KPI calculation.*

Projects are not weighted according to size for the purpose of this KPI.

Requested Date	Delivery	Date initially requested by the customer for the final project delivery including assembly, testing, training etc. The date can be updated if the customer requests a new delivery date after the initial order placement or if changes in specifications lead to a revision of the date
Confirmed Date	Delivery	First confirmed delivery date for the final project completion. If ABB issues a new confirmed date later on, the 1st confirmation is still relevant for this KPI, unless the change of confirmation date is caused by changes in specifications
Shipping date		n/a
Delivery date		Actual project completion date in line with the customer agreement and ABB's obligations

3.4. Incoterm definitions

The Incoterms rules intend to communicate the tasks, costs, and risks associated with the transportation and delivery of goods (Figure 03). They remove uncertainties during the transportation of the delivery and are always part of the commercial contract with the end customer.

In this study the following selected incoterms are used because they are most commonly used between ABB Robotics and its customers.

- CPT – Carriage payed to named place of destination, i.e. cost of shipment belongs to the seller up to the destination point, risk and ownership to the buyer during transportation (International Chamber of Commerce, ICC, Incoterms 2016)

- CIP – Carriage and Insurance Paid to named place of destination, i.e. only difference to CPT term is that seller is obtains an insurance for the shipment. (International Chamber of Commerce, ICC, Incoterms 2010)

- DAP – Delivered at agreed place of destination ready for unloading, cost and risk belongs to the seller during transportation up to the destination point (International Chamber of Commerce, ICC, Incoterms 2010)

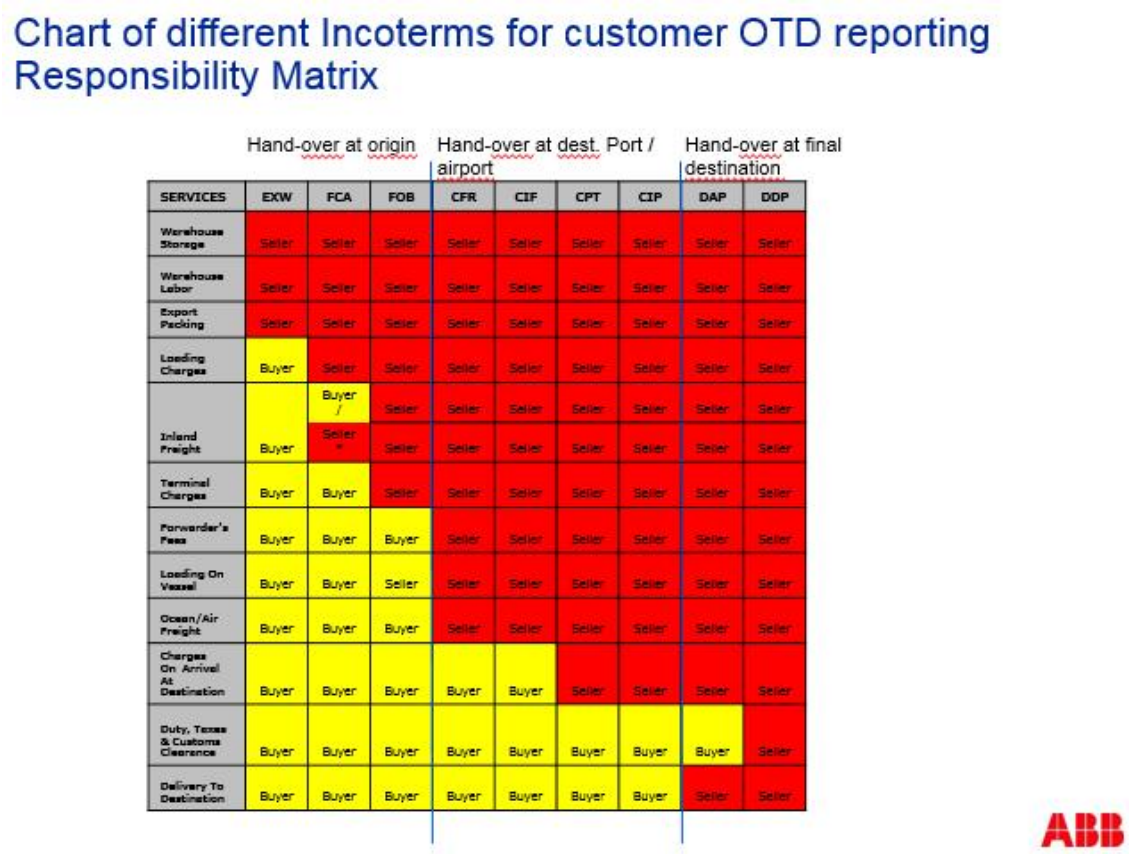


Figure 03. Incoterms responsibility matrix (ABB intranet)

4 ROTD Reporting Process and Baseline

In the following chapters the ABB reporting procedure and ROTD baseline are described.

4.1. Frequency and reporting period

ROTD is reported and evaluated every month for the previous month as any other ABB official KPI. Reporting deadlines are in line with the general monthly deadlines for input into the source system (ABB reporting database Opx Analyzer).

4.2. Reporting Unit

Reporting is done by PGU (Product Group Unit) for all PGU's with sales activities at ABB. However, it is possible to appoint a "lead PGU" within a country which reports consolidated figures for the whole LPG within a country. E.g. if the PG DMRO-4314 has multiple sales offices (PGU's) in Italy and the largest office reports the consolidated numbers as one PGU. In this case system calculates automatically one ROTD average for the whole PGU.

4.3. Reporting Process

Generally, it is the responsibility of the LSU to ensure that the relevant data is collected and reported to Opx Analyzer correctly and on-time. Data collection can be taken from centralized OMS database, or from local ERP system. Both systems have the same data available but for PG 4314 every single transactions is not duplicated in OMS system. This is the reason DMRO needs to report from the local ERP their ROTD figures. PU's need to support for actual delivery date collection when shipment are sent directly to end customers. (Figure 04)

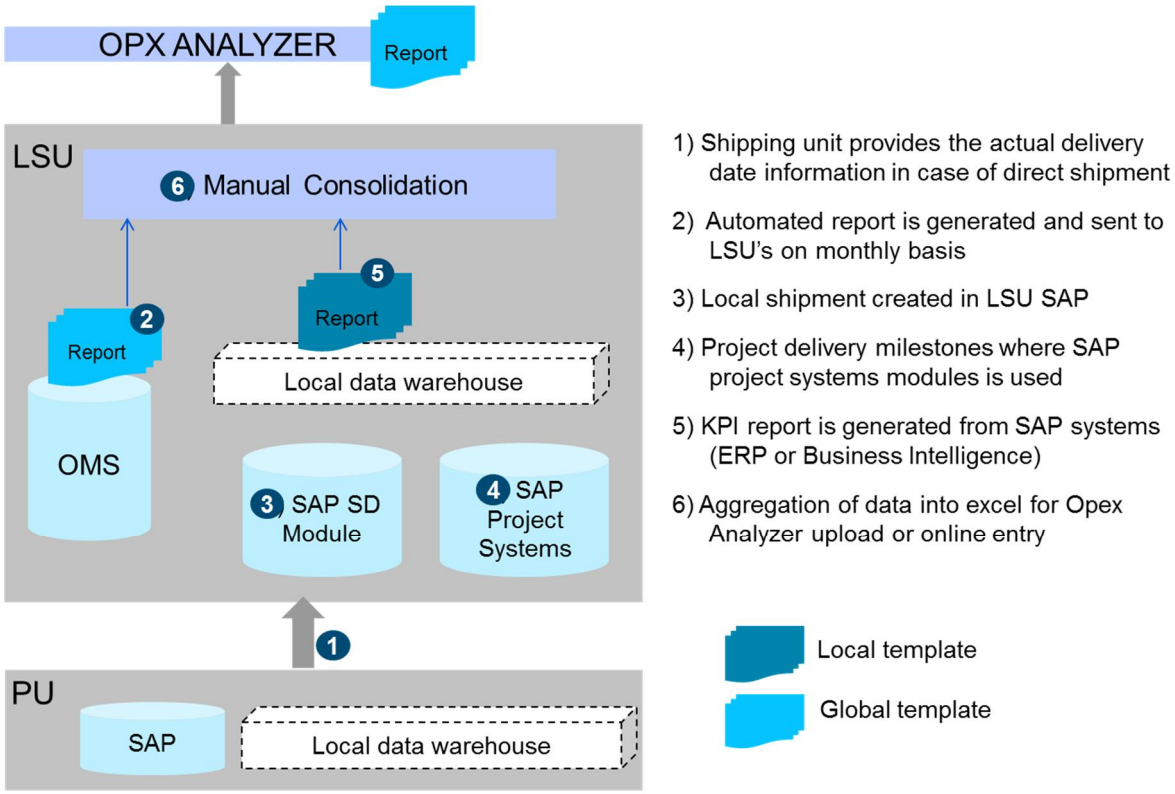


Figure 04. ROTD Reporting process at ABB

4.4. Baseline January 2016

The performance for ROTD in the beginning of the year was very challenging. The rolling 12 month average percentage on PG 4314 was only 34.3%, which was the baseline for year 2016. The number indicates that only roughly one third of the customer deliveries were delivered as requested.

4.5. Benefits of the study

Firstly, customer satisfaction is a vital indicator within a company to fulfill the needs of our external clients providing prompt deliveries as customer requested.

Secondly, by using lean methodology and processes it is possible to find the waste in the delivery process and hence implement the best procedures to improve the current performance.

Before:

- Measurement system concentrating only on factory deliveries
- Incoterms were not taken into account
- No visibility to customer satisfaction from local sales office point of view
- No pressure to improve the customer requested on-time delivery

After:

- Better customer satisfaction
- Possibility to create targets for the local sales offices in terms of ROTD performance
- Commit personnel to serve customers better
- Increased focus on customer's delivery schedules
- Improved efficiency
- Focus on more value adding customer service, more than daily operations with sales order handling

4.6. Organization and Roles

The Local Sales Unit (LSU) is responsible for collecting the necessary raw data reporting the monthly KPI's into OPEX Analyzer.

Production Units (PU) or central stocks (CS) who ship directly to end customers (bypassing the LSU) are responsible for making the delivery information available to the LSU for ROTD reporting purposes. Whenever possible, transportation companies should send digital proof of delivery to the LSU for each delivery.

5 On-time delivery and Lean Principles

The study is based on two theoretical principles, firstly the theory of traditional OTD measurement principle and secondly, lean methodology – principle to run continuous improvement projects in a systematic way to find and determine waste in business processes.

In this study the waste is the delay between customer requested delivery dates versus actual delivery dates taking into account the incoterms used.

5.1. On-time delivery principle

Delivery Performance (DP) is a broadly used standard KPI measurement in supply chains to measure the difference between customers demand and the wished date. Mostly on-time delivery is understood and measured as a factory ex-works performance measure, i.e. how well factory meets the internal purchase order wished date by internal customer. In this study calculation is based on end customer first wished date versus actual delivery date.

It can be interpreted that on time delivery is a measure of efficiency in terms of process capability and supply chain efficiency. By measuring on-time delivery company can get visibility also to the internal reaction time, i.e. how on-time and smoothly customer's changed deadlines can be met. If the figure is low it indicates that there are bottlenecks, inefficient or time consuming processes which are not adding value to the customer. If the trend is all the time below the target level, internal audit and root cause analysis are required. (leanmanufacture.net 2009)

This is the reason why request on-time delivery has got top management intention at ABB and program has been launched to get the process under control.

On-time delivery is very often overlooked in organizations even the calculation formula is very simple; amount of units delivered on-time versus total units delivered. (leanmanufacture.net 2009)

5.1.1. Definition factors

There are two principles to measure on-time delivery, with or without windows. Usually, if the product or delivery is cheap in nature wider windows can be set to meet the on-time criteria. If the product or delivery is expensive tight window is appropriate and also supports the optimal cash flow. Products can also be categorized as per commodity class in a similar way as components and raw materials. A-items belong to the high cost

basked, B-items to the medium cost basket and C-items to low cost basket. (Optimum Design Associates 2016)

In this study the window in +/- 0 days since the automated robotics deliveries are very expensive. It is critical to understand that the agreed window must be communicated and coordinated with the planning lead times in the company's ERP system(s). Robotics are considered as very high cost items and hence are classified as A-class items.

5.1.2. Measurement Factors

Defining OTD criteria within a company or organization and start measuring it is quite easy but over time it might create a real challenge, especially if the criteria is not defined with all necessary factors. One of the most important factors is the **calendar** itself. Are we using calendar days or working days? (Optimum Design Associates 2016)

Another basic measurement factor is the reference date, i.e. does the date refer to **the date the item is shipped, or the date the item is received**? A **promise date** is the date the supplying plant committed to meet. A required date is the delivery date needed by the customer. The promise date is best practice and by far the most widely used in companies. Another important factor is the order fulfillment. A line item is a single line in an order that specifies a product. In order for delivery to be considered on time, each separate item must be closed, meaning the **order is filled**. (Optimum Design Associates 2016)

In this study **working days** are set as a measuring factor and the ERP system is set-up to ignore the weekends and all other public holidays. This principle needs to be set-up in the system and clearly communicated with the customers as well. Incoterms are taken into account, so sometimes the actual delivery date is shipping date, sometimes receival date by the customer. The supplying factory is accountable to consider transit times when determining what shipping date they use in order to supply the material on-time. Transit times are important part of company master data and differ a lot even within on country. Transit times need to be maintained as per customer location.

Promise dates might differ a lot from the original request date and this is reason why factory OTD at ABB shows very good results; the measurement factor is the confirmed

date, not requested date. In this study the **original customer wished date** is the correct measurement factor. For Robotics on time delivery is typically a system delivery and customer is not satisfied before the whole system is delivered and sales order is closed. This is the reason why each partial delivery is considered as late delivery. However, if customer agrees that **each sales order line item** can be shipped by different delivery date, then the lines are considered on time.

Example of OTD as a KPI with target and actual performance

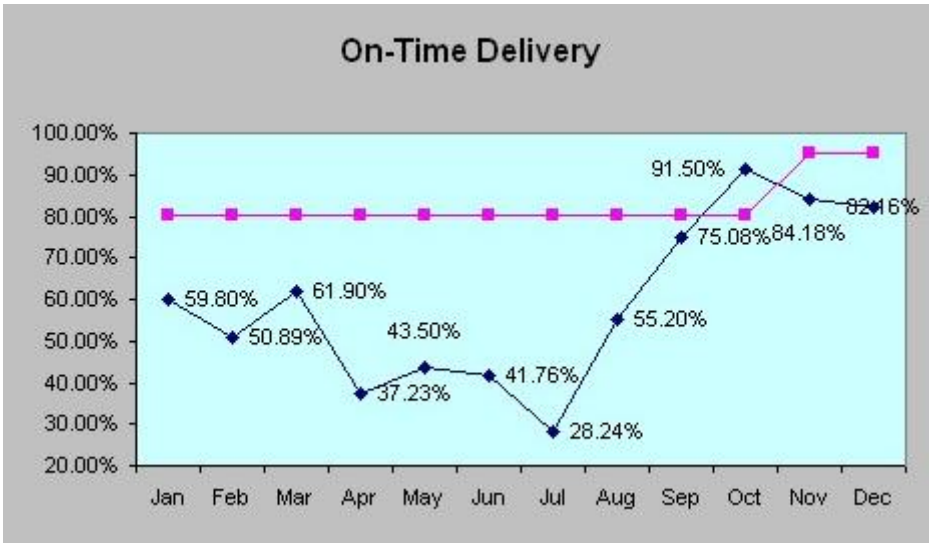


Figure 05. Actual OTD performance and target level (Carpenter Group LLC, 2007-2014)

Figure 05 shows that most of the reported months are below the target level and hence gives an indication of bottlenecks in the processes. It does not explain any of the root causes but clearly shows that over one year only one reporting period is above the target. Further investigation, analysis and improvement activities are required.

ABB has even worse results for 2016 in terms of Request on-time delivery. This is the reason why ABB launched the on-time delivery improvement program in DM Division major countries.

The starting point of on-time delivery at DMRO Italy is approximately 30%.Target level is 60% by the year end. The frequency of OTD reporting is typically left up to each organization, but the frequency needs to make sense. Calculation frequency at ABB is one month.

5.2. Lean Process Methodology

”Those who are not dissatisfied will never make any progress.” is very famous and very true sentence said by Shigeo Shingo – even lean is a term that originated in America – not Japan. However, lean methodology and processes are derived from Japan which is the world class leader in implementing lean processes in different industry sectors. (BES Business Excellence Solutions, Black Belt course, module 2, Lean Processes, 3)

A lean organization contains little to no “fat” in its work processes. It operates in an economical and efficient manner, constantly striving to improve its workflow. However, the primary focus is on identifying and eliminating waste in all its work and operational areas. Waste can be found and minimized in all levels of an organization (Figure 06). Waste is called “Muri” on executive level, “Mura” on cross-functional level and “Muda” on worker station level. (BES Business Excellence Solutions, BB course, module 2, Lean Processes, 14)

In this study the waste is both Mura and Muda, because the logistical process behind the KPI is cross-functional and applicable to different levels of organization. For reporting raw data the waste is called Muda because it is managed by the workers. If the sales administrators and internal purchase order handlers do not understand the importance of the on-time delivery measurement factors the end results might not reflect the truth.

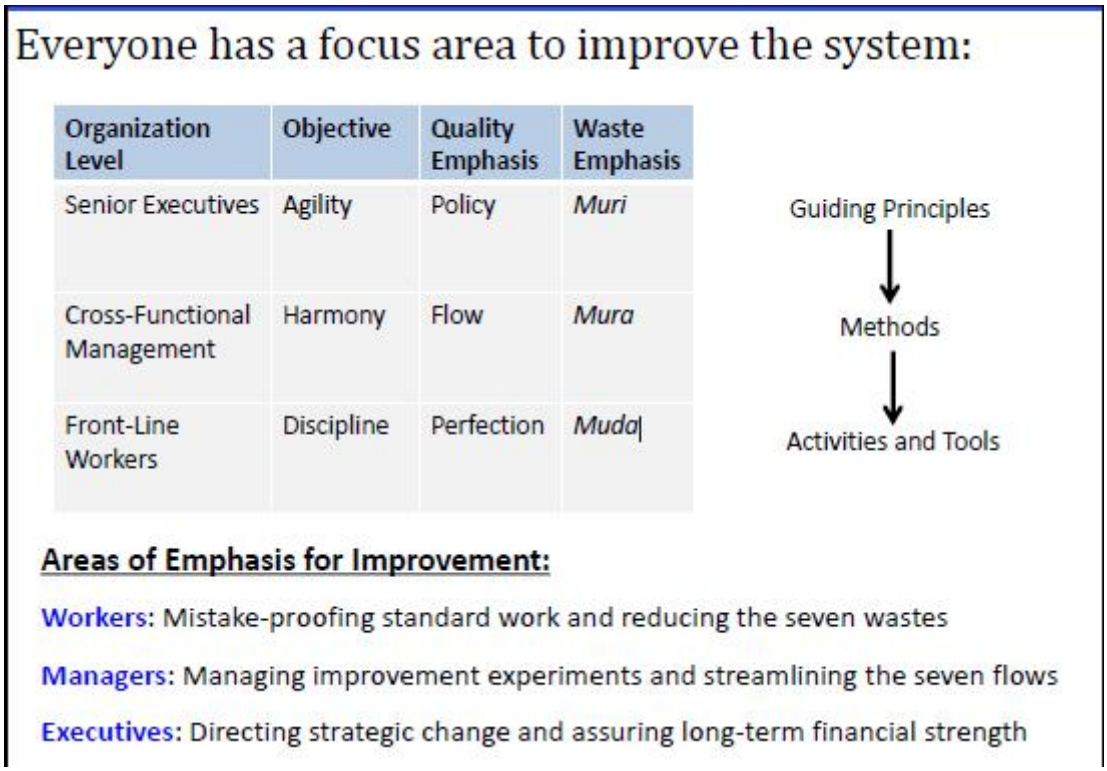


Figure 06, Different type of waste in a lean process, (BES Business Excellence Solutions, BB course, module 2, Lean Processes, 7)

Lean process thinking is challenging the existing processes within a company. The target of lean thinking is to change the ways of working and lead to more efficient processes where all non-value adding work is minimized or even determined. (Figure 07)

Fundamental Principles of Lean Thinking

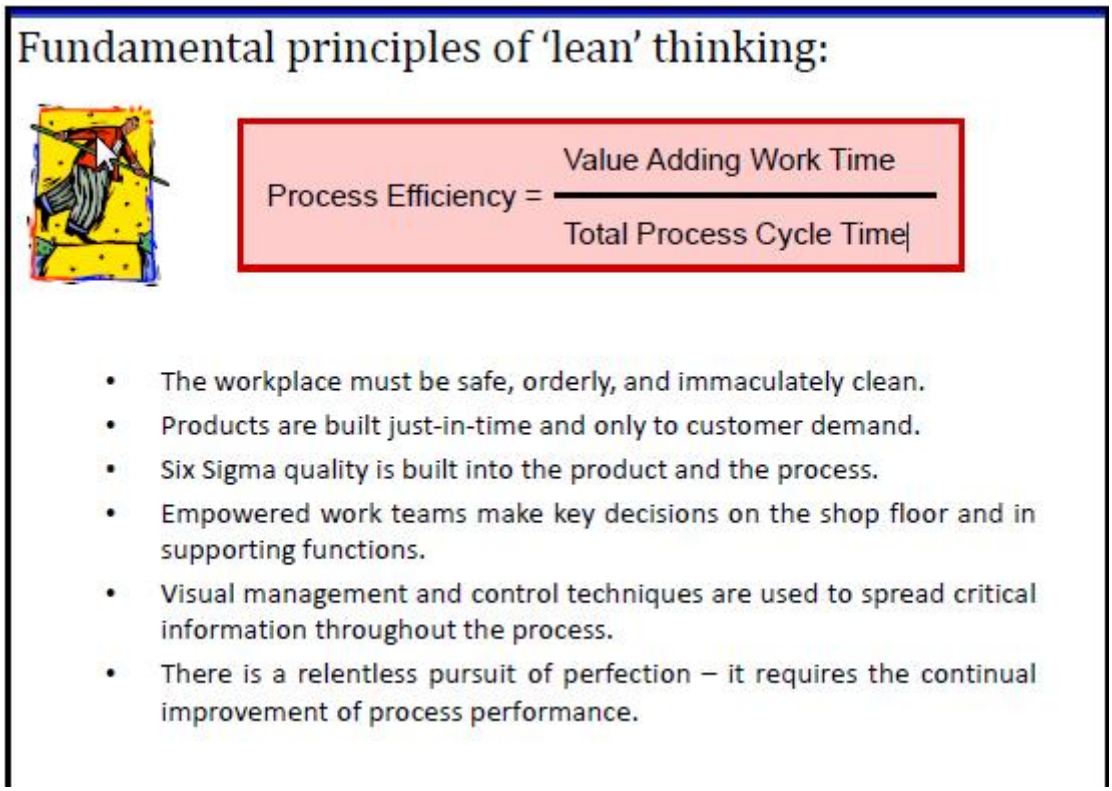


Figure 07, Thinking lean, (BES Business Excellence Solutions, BB course, module 2, Lean Processes, 18)

Lean is the result of efficient through put times (TPT) within a process. Efficient process can be measured only if we know the maximum capability of a process. Efficient process adds value to the customer in terms of better quality, faster delivery or better service. Efficiency limit control is crucial to any process because it has direct impact on measuring the through put time. TPT is the time used from start of the process to the end of the process. Value Stream Mapping (virtaustehokkuus) is basically representing the efficiency of lean within a company. (Niklas Modig & Pär Åhlström, 2013, Tätä on lean – ratkaisu tehokkuusparadoksiin, 22)

5.3. What does a process analysis tell us?

"A process analysis is a logical description of the component set of activities that are arranged in a time-sequence describing a transition of inputs into outputs along with the commands or instructions that govern the operation of this transformation and the set of resources required to effect the transformation." (BES Business Excellence Solutions, BB course, module 2, Lean Processes, 5)

Performance of a process is judged in terms of its effectiveness (productivity), efficiency (availability of process operation, the efficiency in the throughput operation (changeover time, set-up time and operating cycle time), and economics (transaction cost, profit margin contribution, return on capital employed, and cost per throughput unit).
Process performance capability can be evaluated in terms of its current state performance (**an "as is" process analysis**) and also in terms of its potential performance state (**a "could be" process analysis)** depicting a streamlined composition of value-adding and required process components that eliminates waste. (Figure 08)

Lean Thinking - Work Breakdown Structure

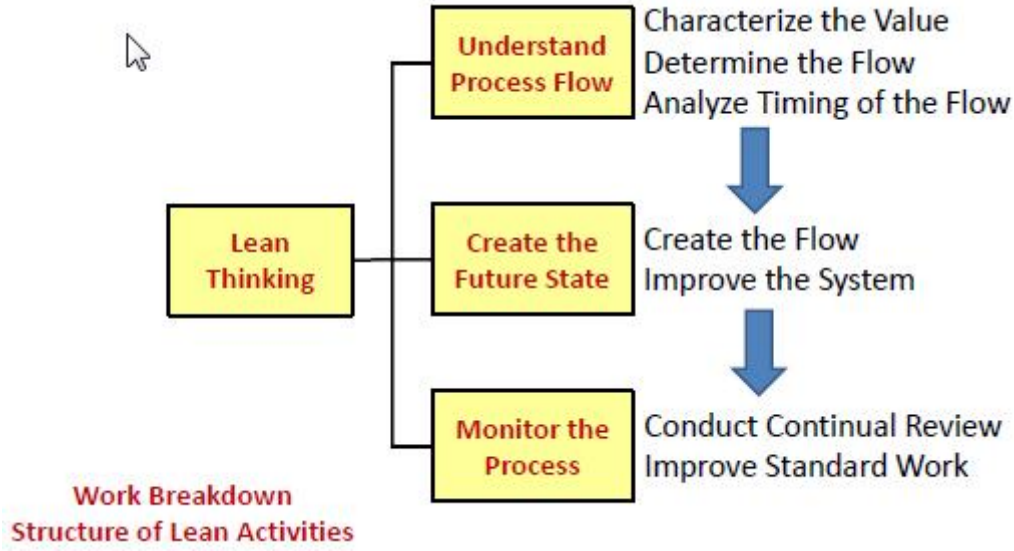


Figure 08, Lean Work Breakdown Structure, (BES Business Excellence Solutions, BB course, module 2, Lean Processes, 19)

For most people lean is an unstructured toolbox of methods but actually there is an underlying systems logic in the flow of lean thinking. It can be visualized by the work breakdown structure of lean activities. (Figure 08)

According to lean thinking work shall be highly specified by work standards in such a way that it can be measured in real time. The flows shall be simple and direct by determining all unnecessary complexity in the processes. Communication must be clear with no space for misunderstandings. Improvement shall happen at the lowest possible level in the organization, under the guidance of a facilitator and by formally agreed approach and methods.

6 DMAIC

DMAIC is the abbreviation of the very controlled and secure way to be used in any improvement project. DMAIC is the abbreviation of words: Define (D), Measure (M), Analyze (A), Improve (I) and Control (C) and it helps a lot when using lean as a guideline.

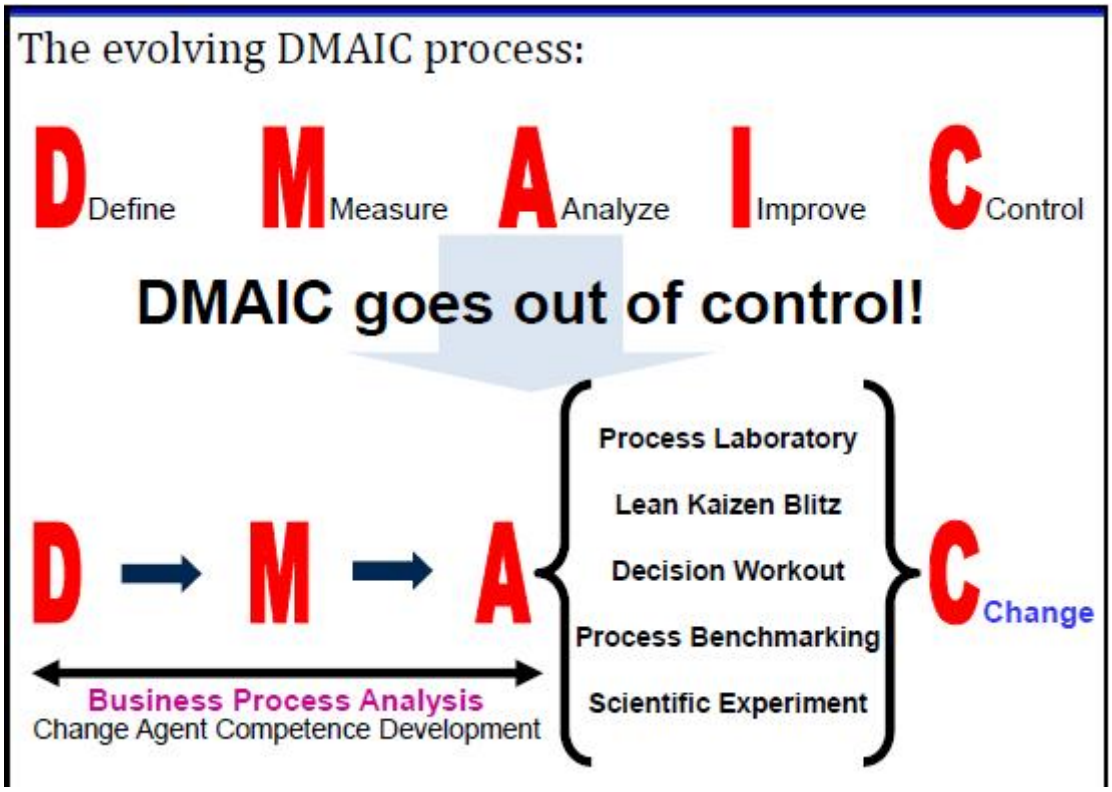


Figure 9, DMAIC process, (BES Business Excellence Solutions, BB course, module 2, Lean Processes, 15)

Each of DMAIC process steps have a set of tools available to clearly identify the problem, measure and analyze which factors are influencing the problem, improve the inefficiency and finally standardize the change and keep the achieved state in control. (Figure 09)

The step-by-step logical process of lean creates a learning experience that unveils the sources of variation. This process links the physical world to the logical world and links customer concerns to processes that satisfy these concerns and delivery customer-perceivable performance. DMAIC identifies dependencies among process factors. (BES Business Excellence Solutions, BB course, module 2, Lean Processes, 15)

DMAIC process describes how the process influences the product and **adds the value that customers purchase**. By using the methodology and process of DMAIC waste in the process can be identified and improvement and opportunities found by reducing variety, eliminating non-value added process steps, centering performance on the customer target and reducing variation in the process. (BES Business Excellence Solutions, BB course, module 2, Lean Processes, 25)

By working smarter, not necessarily faster, might end up big improvement in the process itself. Non-value added work will be minimized and eventually the big win is the opportunity to concentrate on the value adding activities. In case of ROTD value adding activities are to concentrate on gaining more business opportunities on local markets in Italy, increasing the customer service level, customer satisfaction and naturally faster reaction times to new delivery conditions. Currently the opportunities are not utilized because there is no time to do value adding activities but only do firefighting.

By working smarter ABB factories would not need to correct so many mistakes in the middle of the manufacturing process. This kind of corrections can relate to ERP documentation, master data mistakes, wrong wished dates in sales orders and other document details in planning, scheduling, production and shipping phases. However, it is important to realize that each improvement activity causes short-term productivity losses, but in the long term process will be more efficient with less hazards nor failures. (Figure 10)

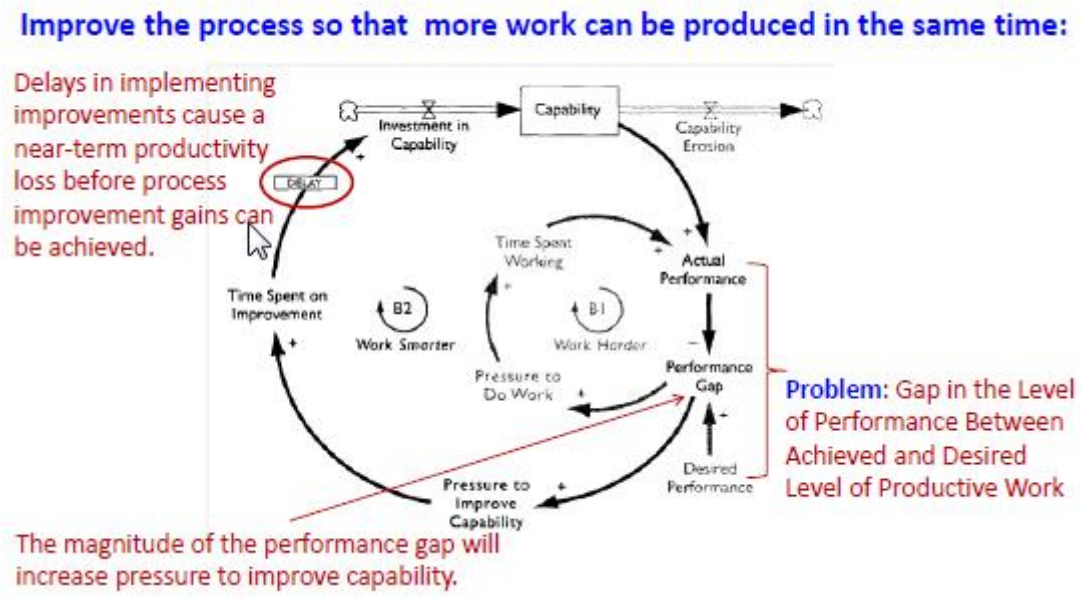


Figure 10, Achieved and desired level of productive work (BES Business Excellence Solutions, BB course, module 2-2, Initiating a Six Sigma project, 12)

6.1 The five Phases of DMAIC

DMAIC is a systematic way of running a lean process within a company. It is a systematic way by using WBS (work breakdown structure) not to forget any vital elements nor steps in the project.

6.1.1. Recognize and Define

By only **Recognizing** the processes where the biggest waste is hidden company cannot improve its performance. But, by **Defining** the waste areas and by prioritizing them, it is possible to improve the processes and hence gain more profit and competitive advantage. Defining the most crucial areas of improvement is a duty of the management team. For almost 1.5 years this management waste, *Muri*, was not raised as a “actions required” topic at ABB. Defining the problem areas can be done via frequently monitoring the company KPI’s and then find and allocate the right resources to run such a project. For define phase the SIPOC chart (Figure 11) is very useful and I have used that to understand the E2E flow in terms on ROTD:

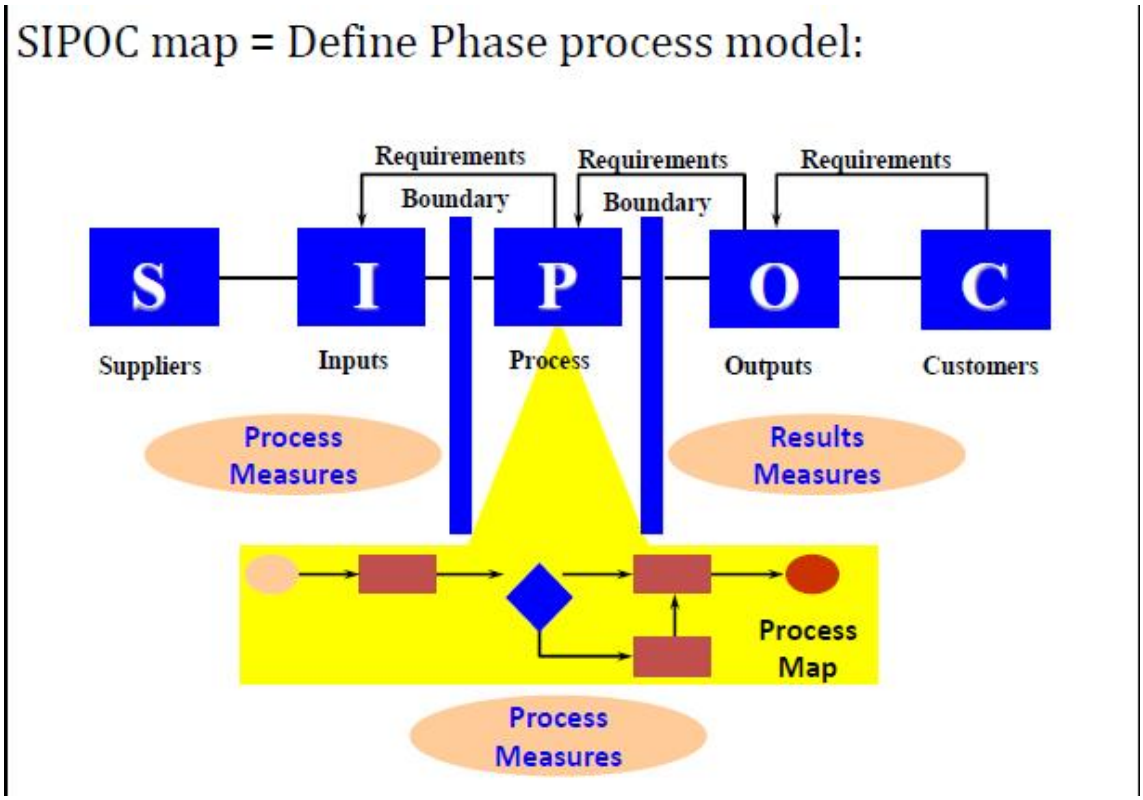


Figure 11, SIPOC map for lean project (BES Business Excellence Solutions, BB course, module 2-3, Business Process Analysis, 53)

Gemba walk is a visual walk through the process in question to give insight to the following questions:

What happened - Who was there - When did it happen - Where did it happen - Why did it happen - How did it happen?

Gemba walk is very eye opening experience because in each process exceptions do take place. By doing Gemba it is possible to see and understand the possible bottlenecks and feel the discomfort by personal interviews. Gemba walk was executed in this study both in the front end (LSO) and back end (PU).

6.1.2. Measure

After defining and committing to the problem area follows **Measure** phase where current conditions and performance level are understood and documented. This phase requires

already data gathering and analysis. Analysis is the phase where we can see by using statistical data which *might be* the vital explaining factor X's, against the factor Y (ROTD).

Traditional fishbone diagram consists of six sub-areas, materials, methods, measurements, manpower, machinery and environment. Each of explaining factor "X"s have some influence on the factor "Y" which is the actual problem. (Figure 12). The Fishbone diagram was developed by Dr. Kaoru Ishikawa and it gives a good starting point to understand the different areas that might cause delays in ROTD process. (BES Business Excellence Solutions, BB course, module 2-3, Business Process Analysis, page 19)

In the measure phase fishbone diagram helps to understand which might be the explaining factors for the poor performance. In this study Y is the "actual performance = actual delivery date" and supplying plants, incoterms and item category (Robotic types) are the vital X's that act as a function of Y. For ROTD is very crucial to find the X's where the biggest variation can be identified and create a plan to change the process in order to eliminate variation.

The purpose of a "fishbone" analysis is to:

- Identify the potential 'cause-and-effect' relationship between the factors contained within a process flow of activities which includes the material, people and measurement aspects.
- Decompose the 'end-to-end' activity into a set of functions using a logical construction of sub-categories.
- Demonstrate the relationship among these various key process factors to illustrate inter-relationships among the measurement system and components of process flow that may impact on the end-to-end process performance.

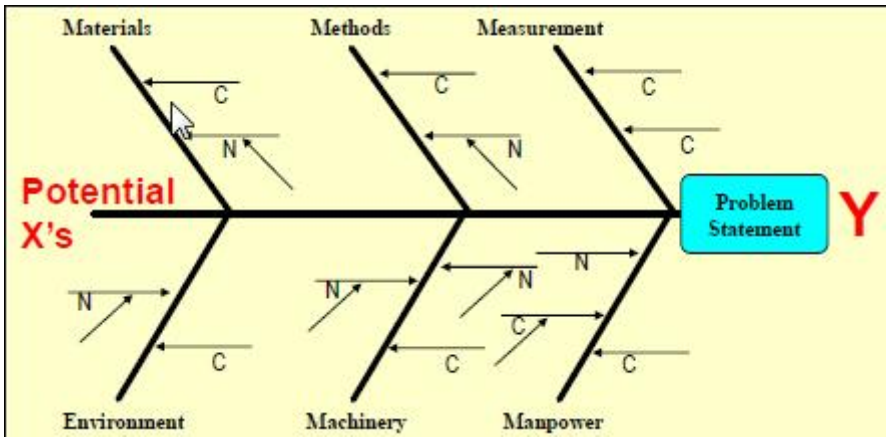


Figure 12, Example of a fishbone diagram (BES Business Excellence Solutions, BB course, module 2-3, Business Process Analysis, 31)

Based on the facts it is possible to start analyzing the possible causes of variation. In the analysis it is possible to find answers to the following:

- How different is the process each time it operates?
- How does the process performance change over time?
- What is the best capability this process has achieved?
- Which sources of process variation explain most of process output variation?

6.1.3. Analyze

After current conditions are understood it is time to start checking which of the possible explaining factors actually cause the biggest variation in the process. Whenever an improvement project has a lot of raw data to be analyzed *Minitab14* is a lean and beneficial tool to run those activities. I have used Minitab in this study in the data analysis to find out the sources of variation in the ROTD process - based on the vital explaining X's against Y (ROTD).

Minitab requires the raw data as an input and calculates and shows results in multiple graphical ways. This kind of graphics can be f ex. Scatterplots, histograms, probability plots or pie/bar charts. (Figure 13).

Below is an example of the Minitab most commonly used reports (box plots, probability plots histogram).

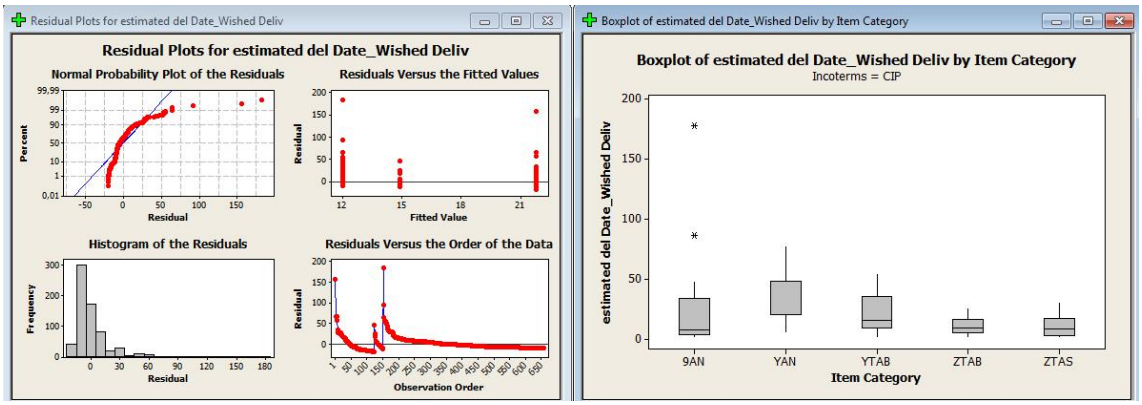


Figure 13, Example reports from Minitab 14, (Minitab14)

To build up the reports user needs to set-up the response factor(s) (X's) against Y in Minitab software tool. This protocol is called ANOVA (analysis of variance) where user needs to understand the input for desired output in Minitab14. ANOVA can be either one-way or two-way process, but it always shows results with the fact whether they are statistically of significance or not. Results are statistically of significance if they are $\alpha = 0.05$. Minitab14 calculates also based on the input if the data makes sense, it compares null hypothesis where all means are equal against alternative hypothesis where at least one mean is different.

In case of ROTD one explaining factor is item category against bad ROTD performance. Second explaining factor is incoterm – by using Minitab14 user can get automatically the relationship how each incoterm together with each item category influence ROTD performance. In this study the basic graphics (histograms, box plots) are used based on one-way ANOVA (Figure 13).

At the end of the analysis phase it is possible to find out the vital X's in the process that have influence on the "Y".

6.1.4. Improve

After problem is identified the next step in the process to find ways to **Improve**. Improvement plan and activities need to be documented and understood by all parties – together with the management team. Without management commitment and approval implementation of change(s) cannot be done. Examples of an improvement activities might be new

delivery routing in the system, training plan, rewarding plan, master data correction plan or even realignment of a customer contract.

6.1.5. Control

After implementation of the new way of working it must be standardized and put into practice in the organization (**Control**). Employees must be trained and motivated to continue with the new operating standard. At the end of DMAIC control points ensure that the new procedure is followed and acceptable level is kept.

6.2. Summary of DMAIC

DMAIC process is a path of a logical learning experience that unveils the sources of variation. It is a systematic way to understand what people are doing the E2E process and by using statistical data find the variation in different parts of the process. (Figure 14). It is suitable and useful for any industry and any process where appropriate amount of statistical data is available. DMAIC is most commonly used in operational parts of an organization, but it can be used in all levels of organization.

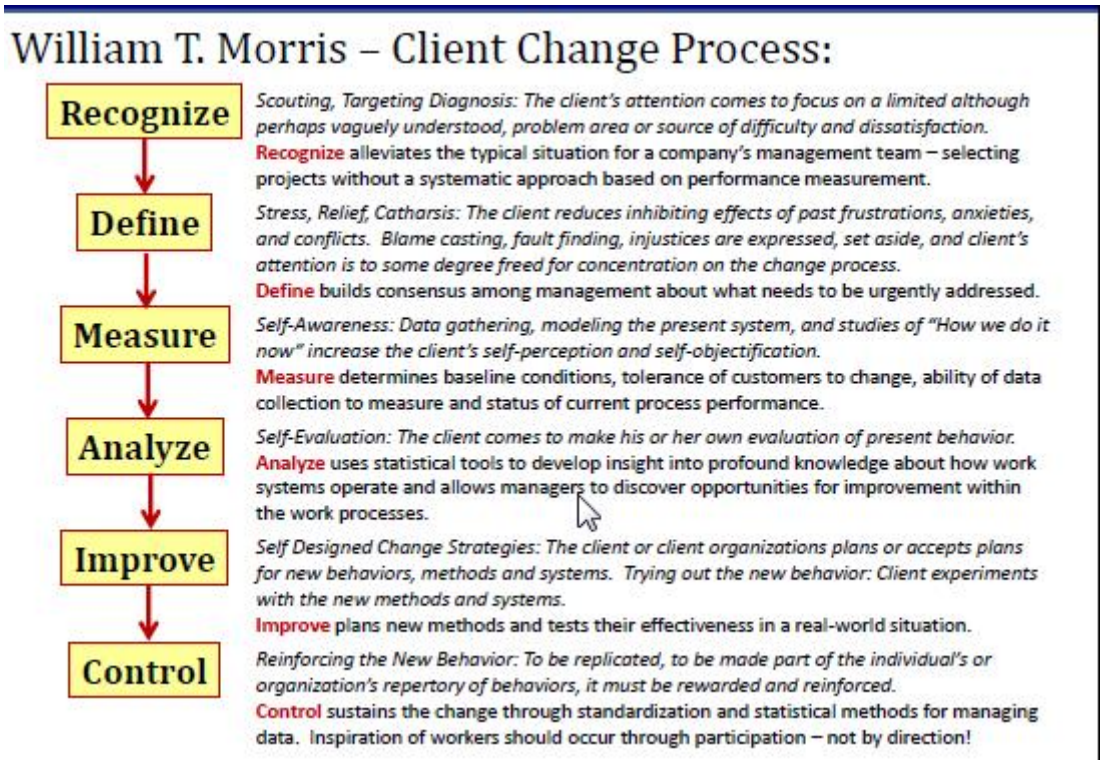


Figure 14, Lean Change Process (BES Business Excellence Solutions, BB course, module 2-3, Business Process Analysis, 12)

7 Lean ROTD Improvement project at ABB

The lean process self-assessment determines how lean an organization is before it begins its efforts at waste reduction. The self-assessment can be seen as an internal audit which considers both the measurement data and objective data.

It can be recognized in the DMRO hypothesis below (Figure 15) that **the less variance there is in the process the better the ROTD at performance is**. This self-assessment indicates Italy being one of the poorest European countries in terms of ROTD performance. In this hypotheses biggest European DMRO countries were selected as reference data. By explaining below shown hypothesis to ABB DMRO management meeting it was clearly decided that project will be launched and resources nominated, both globally and locally to overcome the problem. This was the point when *Muri* was determined from the management process and activities around ROTD could start.

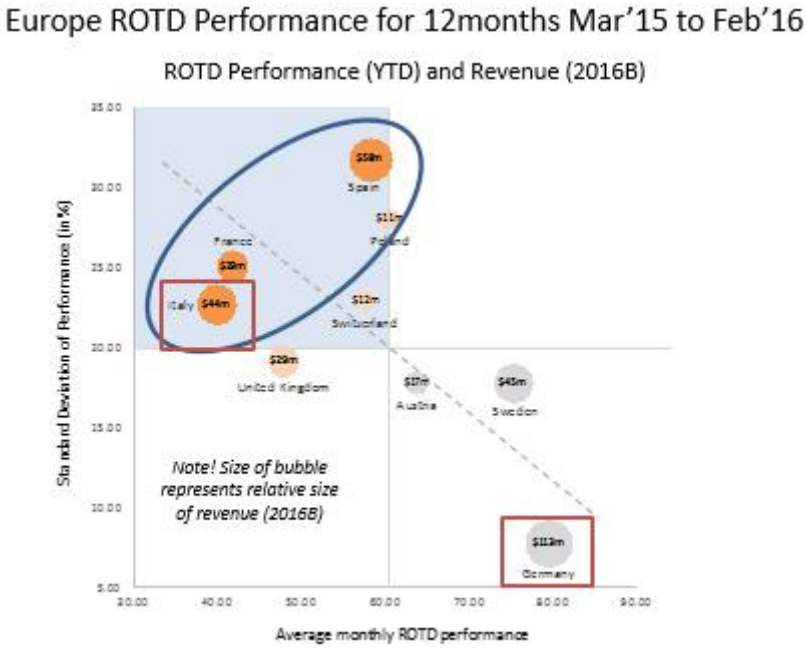


Figure 15. ROTD hypotheses based on ROTD performance and revenue.

The hypothesis shows clearly that Germany has the best ROTD performance and the lowest variation in terms of ROTD whereas Italy has the lowest 12 month mean performance in Europe. (Figure 15). Based on this hypothesis Italy DMRO was selected for this study.

7.1. Define Phase results

Define phase builds consensus among management about what needs to be urgently done and where the budget needs to be allocated to. Define phase consists of characterization, determination and analysis of the current process flow(s).

A SIPOC process map illustrates the end-to-end flow of a business or work process using a high level of abstraction rather than presenting a detailed description of all elements. A SIPOC map is not intended for detailed analysis but is used to identify the focus area for an improvement project.

For characterization and determination **SIPOC** chart was used in this study to understand the document and material flows.

Supplier	Input	Process	Output	Customer
ABB supplying plants Italian local warehouse	Sales order from ABB end customer with requested delivery date	Delivery to italian local stock from factory Drop shipment to end customer from factory	Early/on time delivery Late delivery	ABB Robotics customer in Italy

Figure 16. SIPOC process analysis for ROTD at ABB

From the high level SIPOC analysis the concentration needs to be on the process part. When we understand the input and output, from which the output is the bad ROTD performance, the process in between has the *Mura,* somewhere hidden and it has to be found.

Below described process gives an overall understanding how ABB delivery process works physically and in terms of document flows. Case 1 explains the scenario where physical delivery is delivered directly to end customer, but the order flow goes via two different ERP systems, in the order intake country, and in the supplying plant country.

Case 2 interprets the situation where shipment goes via local Italian warehouse but document flow as in case 1. It can be interpreted already from these two scenarios that in case 2 it probably is easier to trace back the actual delivery date to customer as in case 1 where local sales office is bypassed. To find out these two scenarios Gemba walk was a required step in this study.

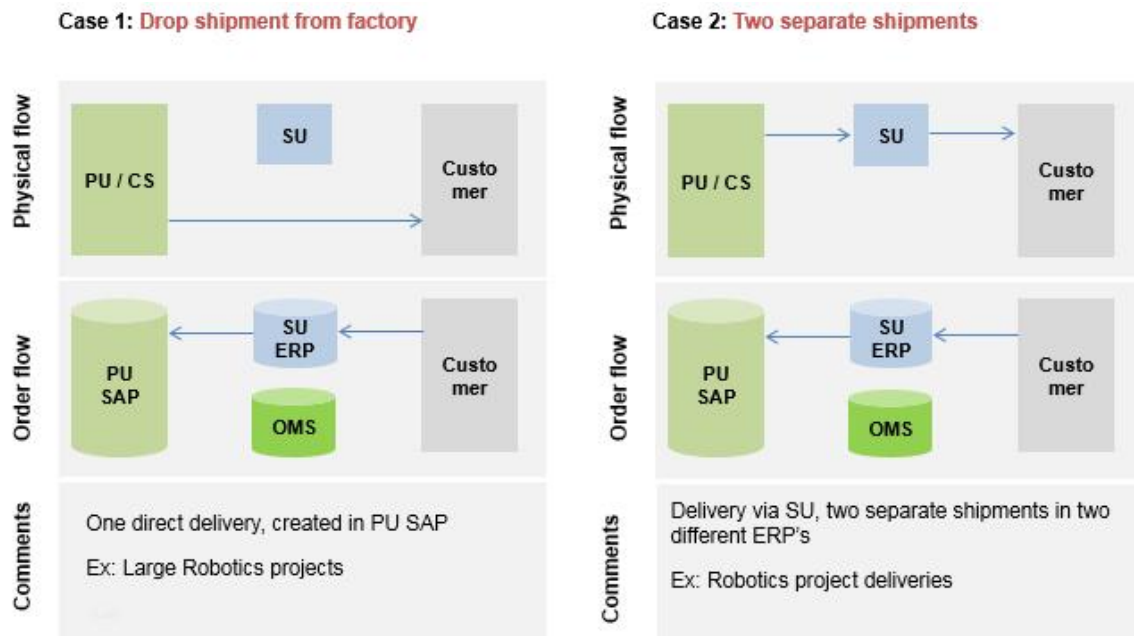


Figure 17, ABB PG 4314 delivery model, (SIPOC phase P=Process)

The theory supporting the process scenarios was Gemba, the visual walk through the process both in the front end (sales office) and back-end (manufacturing plants) – by doing this it was easy to see that there are the two above mentioned delivery scenarios established for DMRO PG 4314 products.

7.2. Measure phase results

Measure phase of the project is the phase where the facts can be measured based on the available data set which is always historical raw data. Based on the historical raw data it can be visualized how much waste the process includes over a certain time period.

7.2.1. Fishbone analysis

For ROTD project fishbone diagram was created by the project team with all possible root causes (Figure 18). Most probable root causes are characterized under methods and measurement.

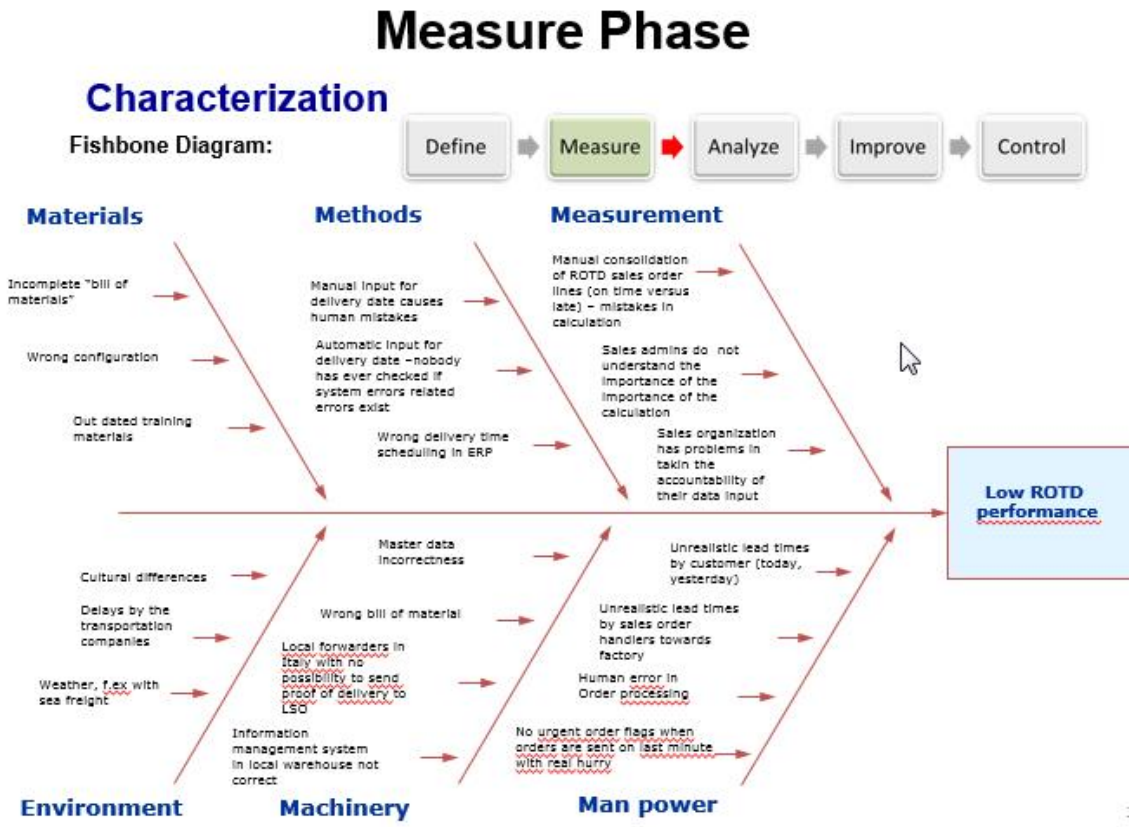


Figure 18: ROTD Fishbone root cause analysis

7.2.2. Historical data analysis

669 lines items out of 1000 line items were late based on the rolling 12 month figures. Average delay (mean) of order lines was 14.4 days. 50% of deliveries were more than 8 days late (median). The result does not take into account any order lines that were delivered on time. The maximum delay in the data set was 195 days, and minimum delay was 1 day. This histogram is done by utilizing the raw data in Minitab14 and results shown as a histogram, excluding all early or on-time deliveries.

The interesting detail in the analysis is that there is a long tail in late deliveries meaning few order lines create quite big negative influence on the overall performance. This fact

already gives strong indication that the tail details need to be checked in detail and corrective actions agreed with the local team. (Figure 19)

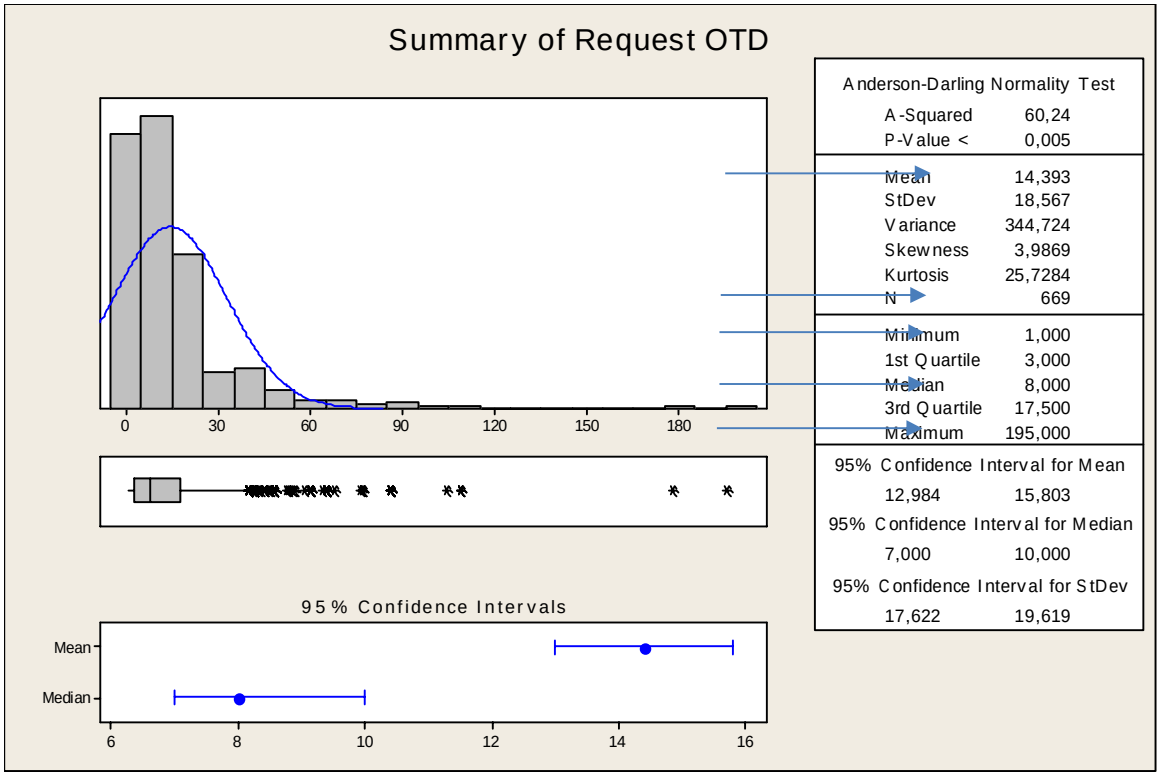


Figure 19. Historical data analysis of ROTD

7.3. Analyze phase results

For analysis I have used Minitab14 as a tool to find out the possible causes of variation in terms of ROTD. I started with the item category to understand which Robot type(s) cause the biggest variation in the process. Secondly, as a vital "X" I used the Incoterms used for the transaction to see whether they have influence on the ROTD results or not. Robotic deliveries for Italian markets are sent either locally via local warehouse or as a drop shipment from the supplying plant as demonstrated in the process chart (Figure 19). Even for the local shipments the back-end factory manufactures the product based on the orders received. Robotics are non stockable items. The supplying factories for Italian markets are China and Sweden.

7.3.1. Item category analysis

Based on the item category analysis (Figure 20) it can be intepreted that there is a lot of variation in each of the product type group.

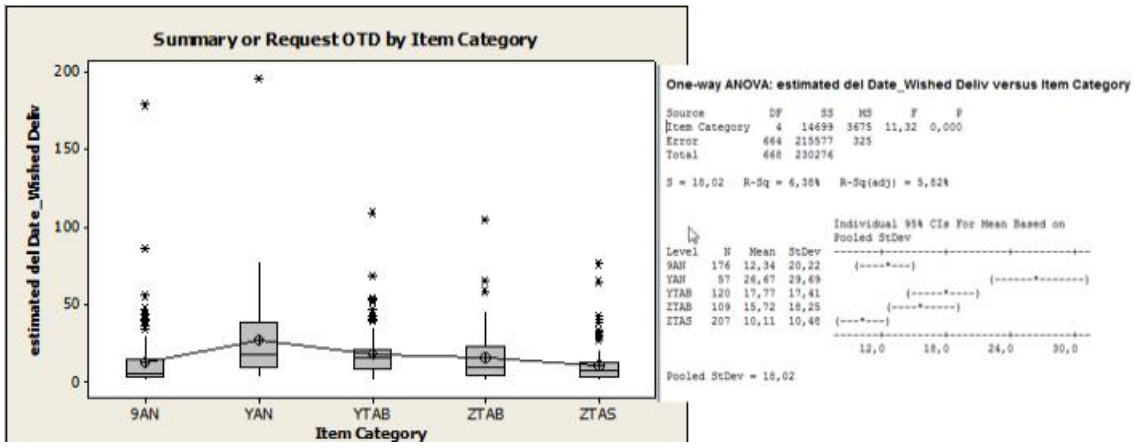


Figure 20. ROTD variation by item category

Item category YAN however has the biggest variation with average of 26,7 days delay. Item category ZTAS has the smallest variation. Interesting fact is that YAN, which also represents delivery via local stock has bigger variation than ZTAS which is drop shipment from Sweden or China. Based on this finding the improvement actions will be directed to YAN which will have biggest influence on the current bad on time performance. ZTAB and 9AN were left out from this study.

7.3.2. Incoterm analysis

After item category analysis incoterms were the second biggest possible root cause (figure 21).

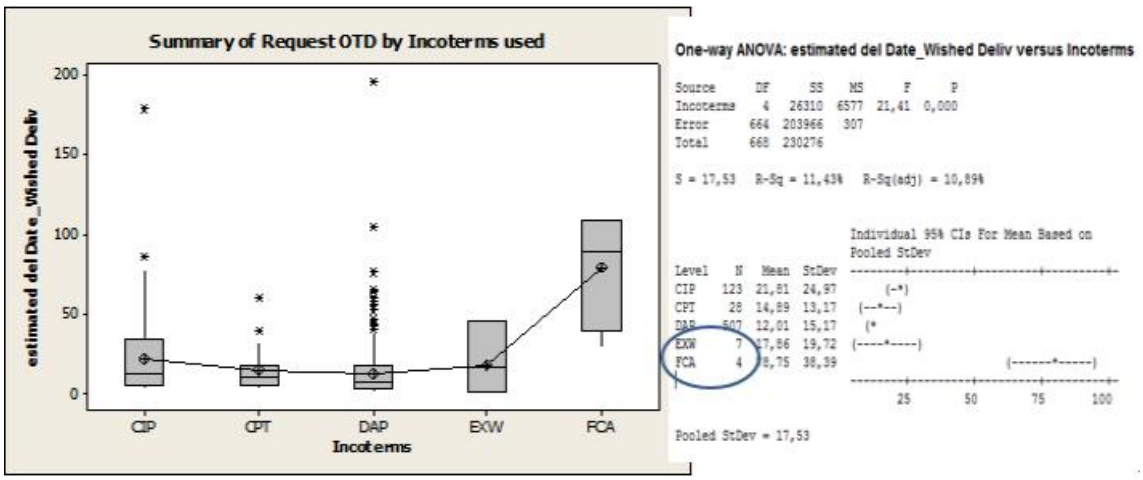


Figure 21. ROTD per incoterms used

Based on the result (Figure 21) FCA and EXW can be left out from further analysis because those sales order lines are not relevant in terms of number of transactions. It can be intepreted that majority of Robotic deliveries are on sellers responsibility. In other words, the majority of transactions have either CPT, DAP or CIP as an incoterm and hence are worth further study. Mean delivery delay for CPT, DAP and CIP is between 14.89 and 21.81 days.

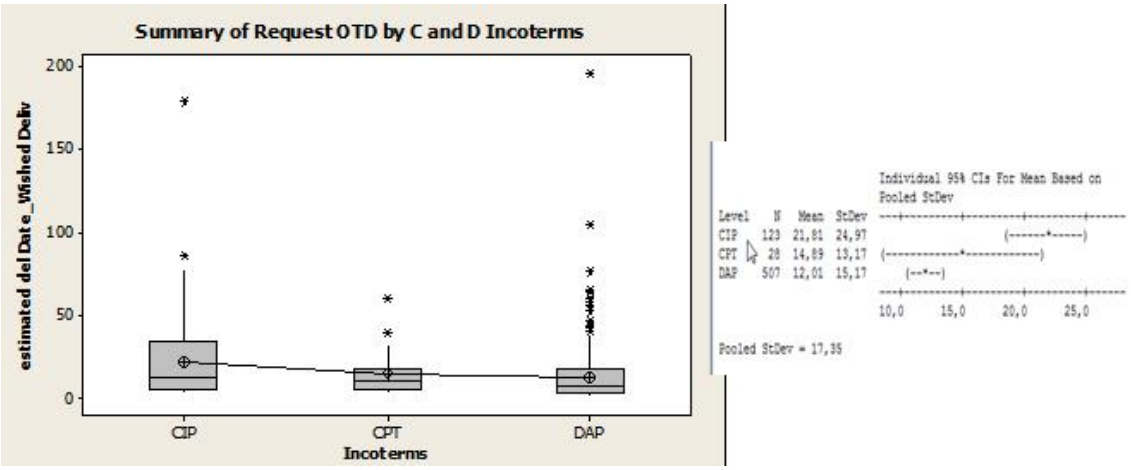


Figure 22. ROTD per incoterms without EX-works and FCA

As s summary of C- and D-terms it can be intepreted that sales orders with CIP term have more delay than sales order with DAP term. However, sales orders with D-terms represent the majority of total deliveries. CIP term orders have the biggest variation. CPT has very small sample size. Therefore, deep indications cannot be done within this study. Outliers for CIP and DAP terms have some influence in the results, but in terms of the total amount of data those outliers are meaningless (Figure 22)

7.3.3. Supplying plant analysis

Supplying plant represents the delivering factory or central stock (Delce) in Menden Germany (Figure 23). Target of this analysis is to find the root cause(s) which supplying plant has problems in delivering on time to the end customer/local Italian stock. On the following picture all supplying plants are presented to get the overall picture of the logistics routing.

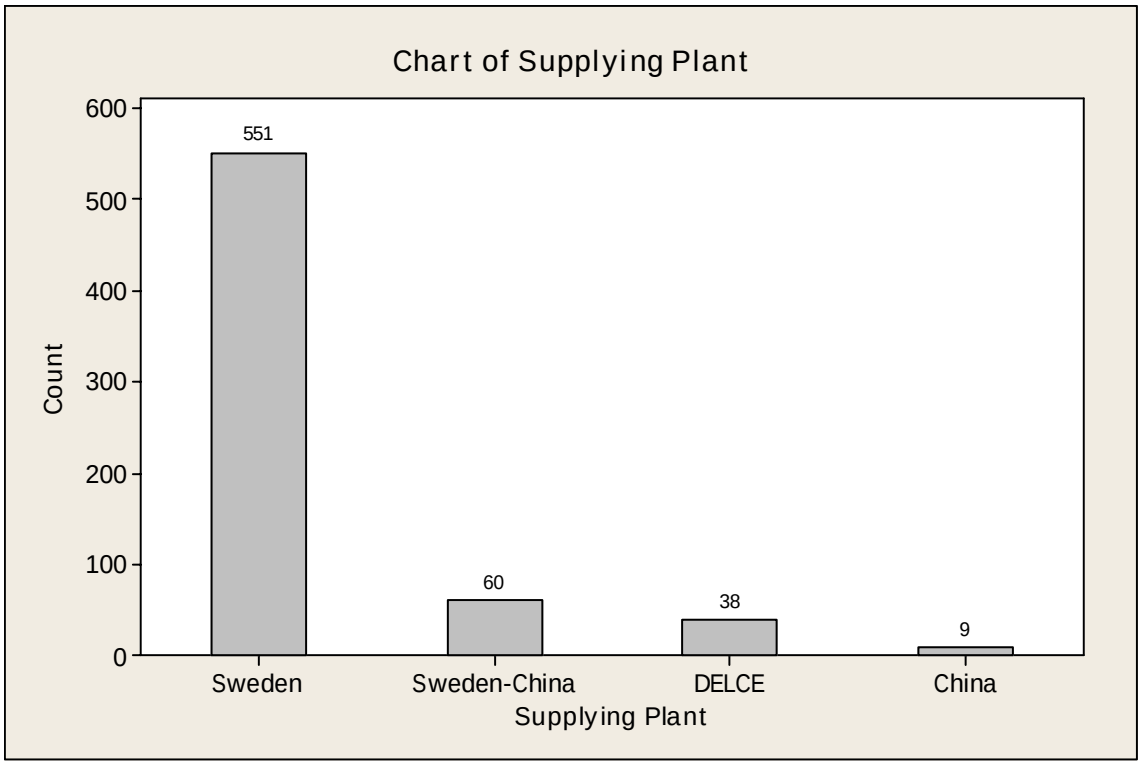


Figure 23: Supplying plants for PG 4314 Italy, all item categories

It can be immediately determined that Sweden is the main supplying plant for any item type deliveries to Italian customers. However, China is the secondary internal supplier and some of the deliveries are also shipped from European Central stock (Delce).

In the following analysis (Figure 24) the same analysis is demonstrated in a two-way ANOVA diagram, where also the item categories are shown.

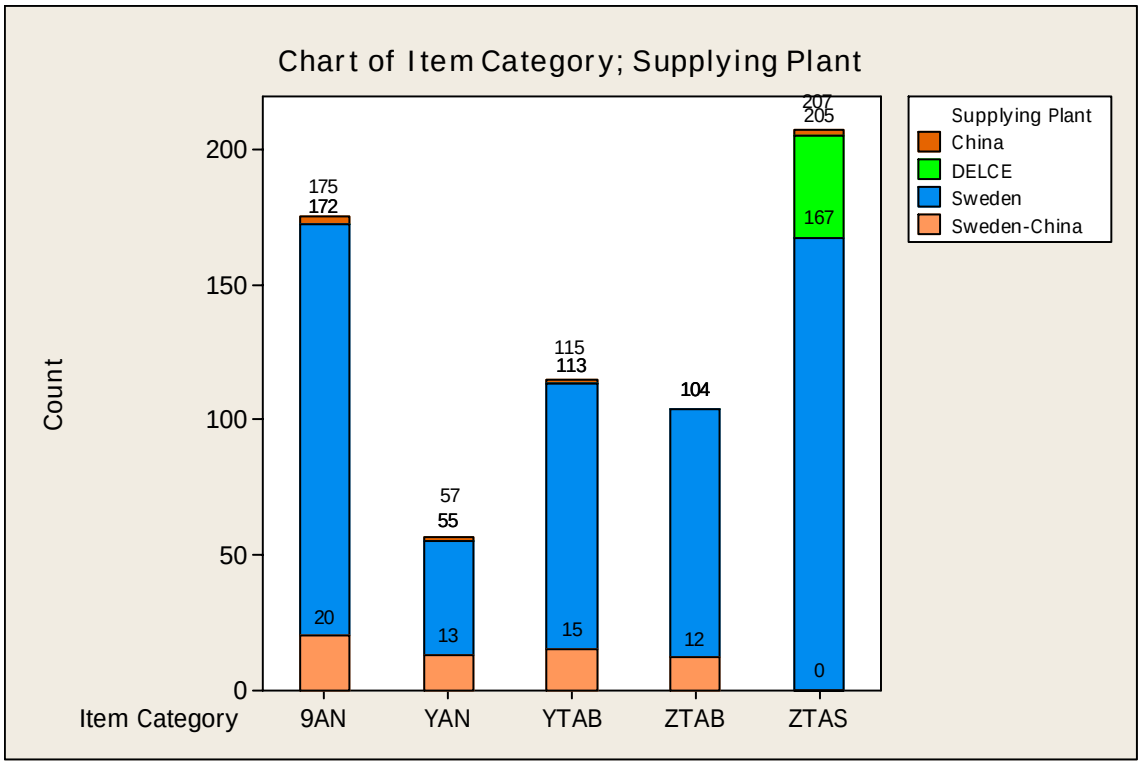


Figure 24: Supplying plants for PG 4314 Italy, divided by item categories

Item category YAN is delivered by China and Sweden. Products manufactured in either Sweden or China it can be determined that the co-operation between Italian sales office and manufacturing plant is not working as it should. There are a lot of delays in the deliveries.

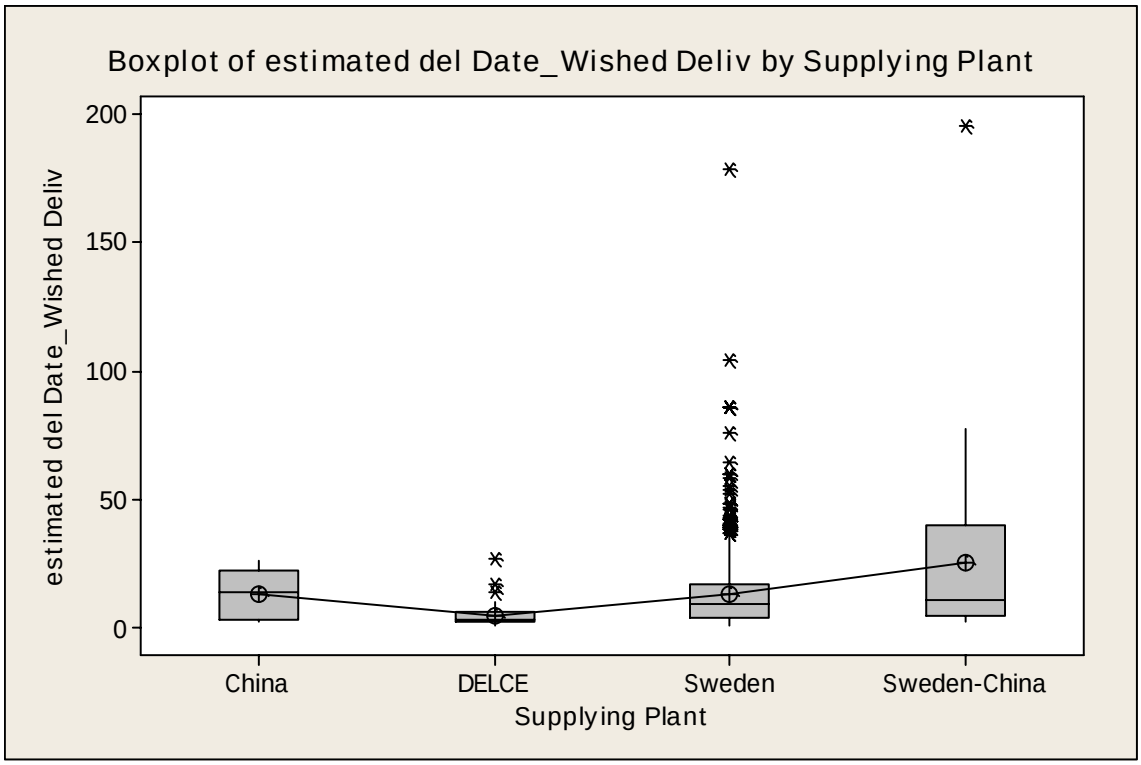


Figure 25: Supplying plants for PG 4314 Italy, with individual orders

Sweden has big volumes and a lot of problems in terms of individual orders. Out of 550 order lines the overall performance is on unacceptable level and there are a lot of outliers (Figure 25). However, the outliers has no major influence on overall variation.

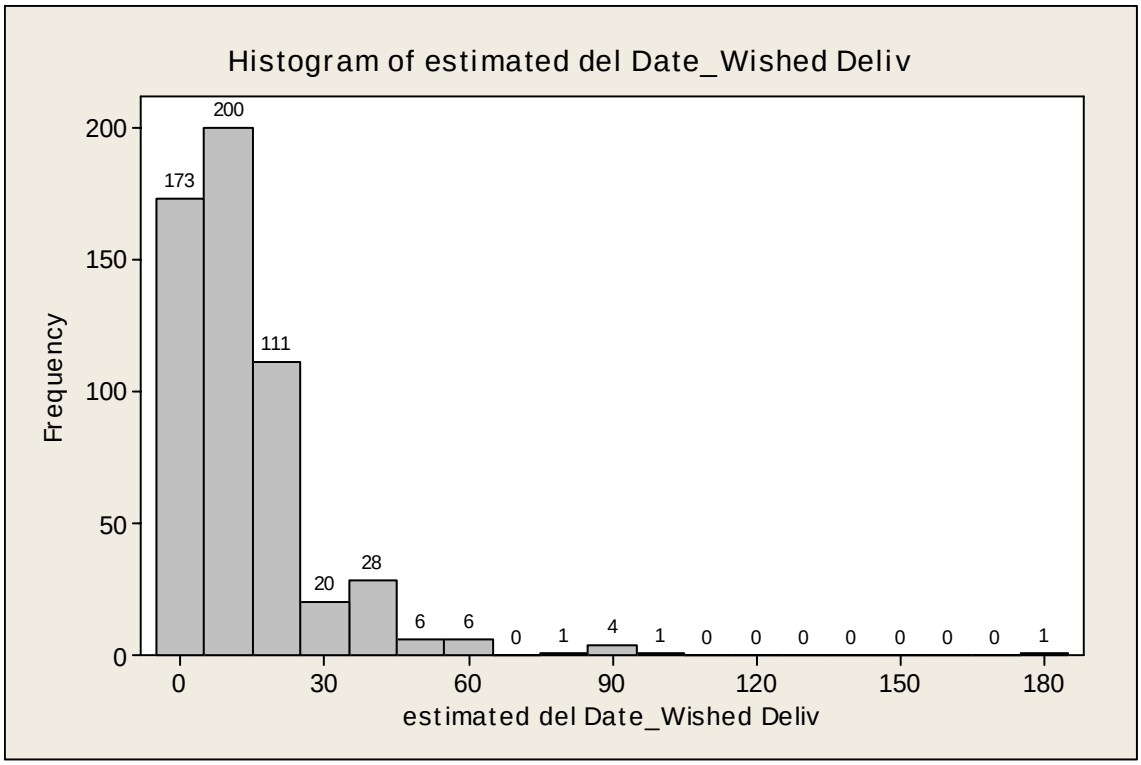


Figure 26: Sweden Robotics deliveries to PG 4314 Italy

In above analysis the outliers can be seen more clearly (Figure 26). Minority of the orders has huge delays to Italy and hence they should be investigated and corrected to tackle that part of the process. This way ABB can achieve already improvement low hanging fruits in the process.

Supplying plant as explaining factor seems to be the most critical one, but very intensive and a big dimension. It will not be part of this study, but will be executed as a separate black belt project.

7.4. Improve phase results

The objective of Improve step of DMAIC is to identify factors that will later on control the statistical problem, shift the critical factors mean to the target performance and reduce the variation in the process. This way the process will get more consistent with certain predefined limits desired by customers. The performance target is to be robust and standardized where performance is under control based on the improvement activities implemented in this phase. (Six Sigma for Business Leaders, Gregory H. Watson, 18)

Deliverables of improve phase are the key X's that improve the performance of Y. Tolerance limits need to be set-up for the key X's in order to maintain control over the process. In case of ROTD tolerance limits are the ROTD target levels for Robotics.

The picture below (Figure 27) lists the gaps of the fishbone analysis, interviews during the Gemba walk and naturally gaps identified in the previous step - analyses of variance (ANOVA). These themes of analysis will now be broken down and prioritized, as not each and every possible root cause can be solved by this study. However, the gaps can be divided in three main streams, issues at sales units, issues between PU and LSO and issues at the back-end.

Already at this phase it is a known fact that the issues at the production units are not in the scope of the improvement plan but those topics will be raised as a potential initiatives for a separate black belt project. Issues in the front end and some issues between the LSO and PU will be solved by this study in order to improve the ROTD performance. The figure below shows the counterparties and their involvement in the improvement activities.

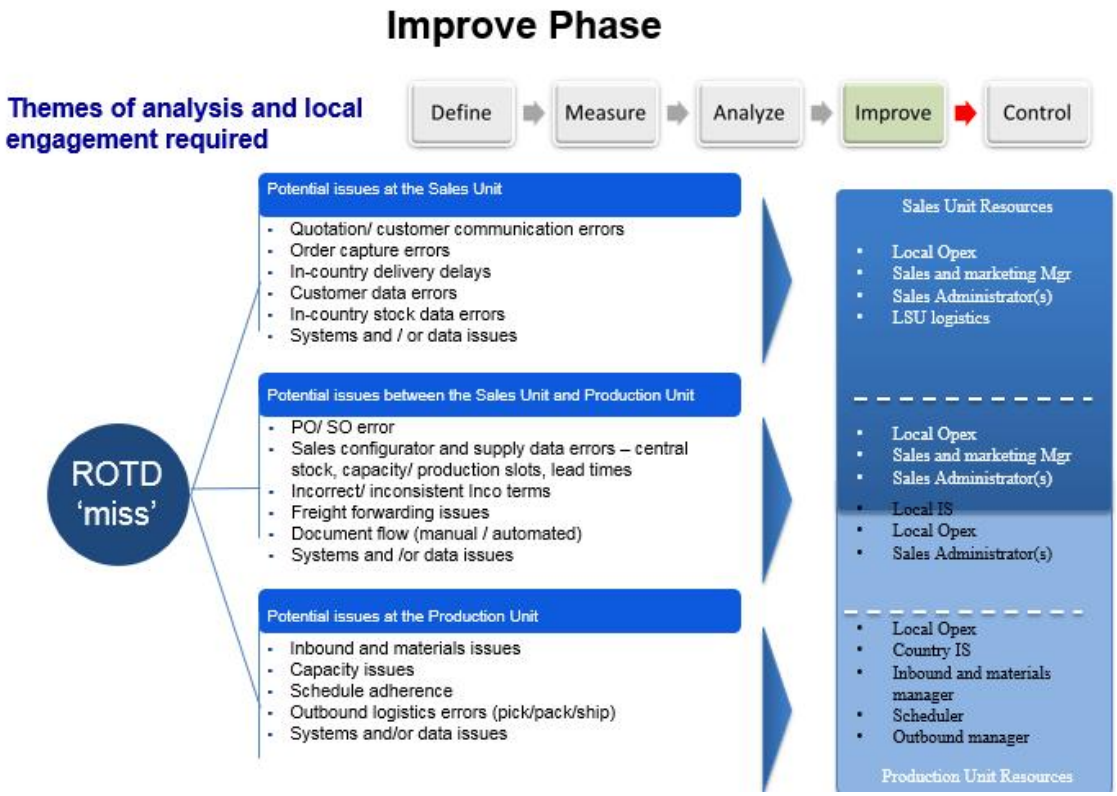


Figure 27, all possible improvement activities based on the analysis phase results

7.4.1. Determination of waste

Based on the findings above is could be clearly seem that corrective actions on different parts of the process were required. Waste needed to be eliminated. Below mentioned actions were agreed by the steering committee where results were introduced and prioritization work shop executed. Finally, not each and every corrective action was implemented within this project but then added to the DMRO project pipeline for the future.

7.4.2. Delivering plants with long tail

This chapter is applicable for Sweden and China factories. The analysis showed that especially Sweden has big statistical variation in terms of long tail for some deliveries. Additional black belt project is recommended by myself to the Steering committee meeting because the size of it – this improvement would have been impossible to include in this project. However, the analysis showed very clearly that minority of the deliveries cause relatively high negative impact on the ROTD. Sponsor of this project agreed and PU development manager added the sub-project to the DMRO project plan pipeline with priority high, estimated execution Q1/2017, with a comment that the BB project will be facilitated and lead by local Swedish and Chinese DMRO Operations and Excellence team, not global team. Global Q&A team will only act as supportive channel.

7.4.3. Italian local warehouse

Italian local warehouse management system internal audit and possible realignment was executed, answering to the question found by this study - why local deliveries are causing more delays than drop shipments from factories? Internal audit was executed in the Italian warehouse and many systematic mistakes were found and corrected in the local system, especially within the master data.

Old dated standard lead times for YAN Robots were corrected by new master data upload facilitated by the project but executed by the local team. At the same, other item category lead times were uploaded to the system as well.

Local warehouse had illogical layout compared to the activities performed in the facility. Warehouse was refurnished and each activity has now a new isolated space for testing, software configuration and other fine tuning before shipment to end customer. Furthermore, small cabinets with required material stocks were placed in each testing area with new storage locations (required a small system configuration). This effort was executed by using lean methodology.

Automated interface (front-end tool) from customer order entry had OLD DATED product configuration specifications, customer could choose wrong and inconsistent system deliveries to their existing systems. R&D responsible persons were instructed to update all manuals and configuration specifications for each Robotic type for PG 4314. This routine was added as a part of the official R&D product launch/upgrade process as additional check point. Outcome of this activity is that customers cannot any more select items incompatible to the existing set-up.

Data cleaning activities – all old products/product versions were deactivated in the local ERP system and all inheritance rules within PG 4314 item categories were removed. When a new version is launched and set up in the system, all related master data, including delivery model and lead times, need to be updated. This will eventually lead to more robust and controllable process and hence have positive influence on ROTD.

7.4.4. Training requirements

Training need was obvious both externally and internally to understand the importance of the DATES on the original sales order. Training was executed both for Italian sales office and especially for ABB key account managers who trained with the local language the end customers. We launched at the same a concept of “train the trainer for ROTD” to be leveraged throughout the organization because the training concept is similar regardless of the business unit.

ROTD improvement project planned and executed the trainings for ABB employees in the sales office, but as we could not contact customers directly. Customers were trained by key account managers in parallel. Main message to customers was to use the *realistic* and agreed terms and conditions in their purchase order and if urgent order is required it has a special *new order type. It means in practice that* urgent orders are prioritized in

the back-log and scheduled differently, as an emergency order. New order type was easy and quick solution to distinguish between normal and urgent orders. Before the change customers “flagged” all orders urgent and most of the orders were delivered late. There was no control over the customer front-end ordering process.

For local sales administrators the change was to eliminate the buffers in terms of time when ordering from the supplying plants. Earlier, the operators did that by default without understanding the consequences, and got the desired delivery dates even more unrealistic. This issue was fixed by E2E process training to emphasize the consequences if users manually add unnecessary buffers to the delivery chain. However, this part of the process was left untouched system wise, as there has to be an option for the operators to change the sales order data. We could not interrupt the related process, f. ex reverse order processing etc.

7.4.5. Actual delivery date

Transportation lead times were corrected by the master data update earlier, but the actual delivery date is the date when customer receives the delivery according to agreed incoterms. In cases of EXW and FCA it is pretty simple as factory can signal to the LSO the date when delivery is ready for picking and that is recorded as the actual delivery date.

In cases of C- and D-terms situation gets much more complicated as the forwarder only knows for sure when the delivery is handed over to the final destination. Fortunately ABB uses the global big forwarding companies within Europe, DHL and Schenker and after a work shop (facilitated by the project) with these two biggest players we found out that system-to-system capability exists to signal the actual delivery date - not only to the factory ERP - *but* also to the LSO ERP. This required, however, additional budget for this project for establishing an external connection with the key forwarders, testing and go-live activities. Steering committee had to be consulted once more, but they saw the advantages of the investment and this pretty huge effort was also implemented. This was a huge advantage for Italy because now they can trust on the actual delivery date results 100%.

7.5. Control phase results

After the improvement activities were finalized the control points were easily qualified by the project team. Where ever a corrective action was implemented a control point is required to make sure that situation does not get out of control.

Control point for the supplying plants is not applicable as the project will only be implemented in the future.

Control point for master data updates and cleaning activities was agreed with local management and accountable persons nominated. The normal routine check-ups will be done by the local Operations and Excellence team once a quarter. Without hiring new personnel some adjustment were agreed with the local management. One persons was nominated as a master data coordinator to make sure lead times are updated, old configurations are not orderable and transportation lead times are maintained in the local systems. Part of his existing duties were distributed to the colleagues which did not then add work load enormously for anyone.

Training plan was updated and training requirement was escalated to the Division Training department to include the web-based online trainings for the new employees and updated for the existing personnel.

The protocol agreed with end customers was a quarterly retreat where the NPS scores and red flags are treated together and possible actions addressed to right people. Key account managers are facilitating these meetings and results communicated to the sales office and O&Q team. Same applies with the forwarding companies. To be able to check the reliability of the proof of deliveries new monthly report was configured in the local ERP. This report shows all sales order line items with forwarder identification and a flag if proof of delivery is not received by ABB. This way the system issues can be fixed especially now when the automated process is new and might have some bugs. However, the purpose is to make sure ABB Italy receives the actual delivery date for each delivery. This is not the 100% truth as there still is local minor forwarders which do not have capabilities for integrated solution – in these cases the standard lead time solution remains, but this is now the minority of the volume.

The control point over the ROTD performance is set at year end according to ABB level performance evaluation process. For 2017 it will be possible to set-up a realistic target level for Italy DMRO PG 4314 because we have a reliable baseline that we can trust on.

8 Reliability, validity and verification of the study

The process of the thesis was simple. Firstly all possible X's, the contributors against bad Y (ROTD) performance, were taken into account. By running the analysis the data, by using statistical lean tools it was easy to limit the vital X's against bad ROTD on concentrate on the fundamental ones only.

Reliability level of the study is very high since it is mainly based on statistical system data of the history transactions. Bad ROTD performance is a direct inheritance of both systematic human errors in the process as well as some system gaps that were corrected.

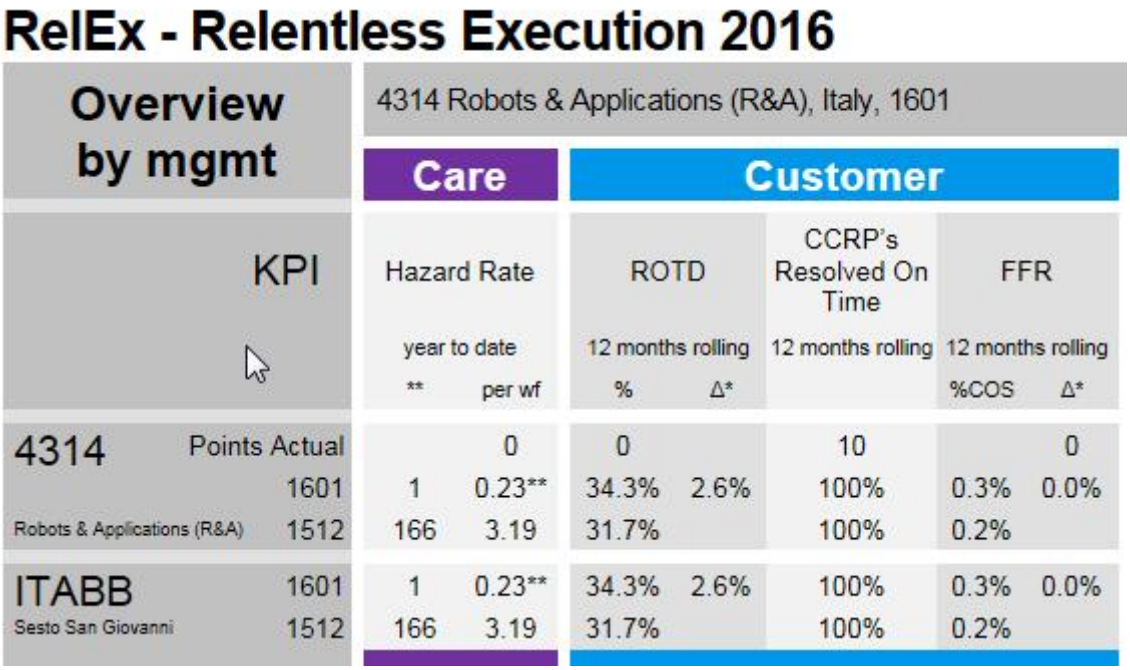
Validity of the study is shown to be true since the frame work was based on valid theories and operating models used by ABB. Furthermore, used procedures (historical fact based raw system data, Gemba, statistical methods, lean methodology) showed the waste in the process where improvement activities were required. The sampling scale was correct and the related KPI showed the increased ROTD percentage after implementation.

Based on the DMAIC analysis phase the achieved results were interpreted and verified with criticism. The results of the study fulfill the expectation defined by the research question.

9 Performance Evaluation before and after Implementation

After all corrective actions identified, analyzed and the agreed ones also implemented within DMRO PG 4314 it can be clearly seen that the corrective actions inherited much better performance compared to the beginning of 2016. The study was originated from the bad performance (34%) but leading into good performance in terms of ROTD. Furthermore, the study was following the lean protocol all the time.

ROTD performance in PG 4314 Italy, January 2016, before implementation:



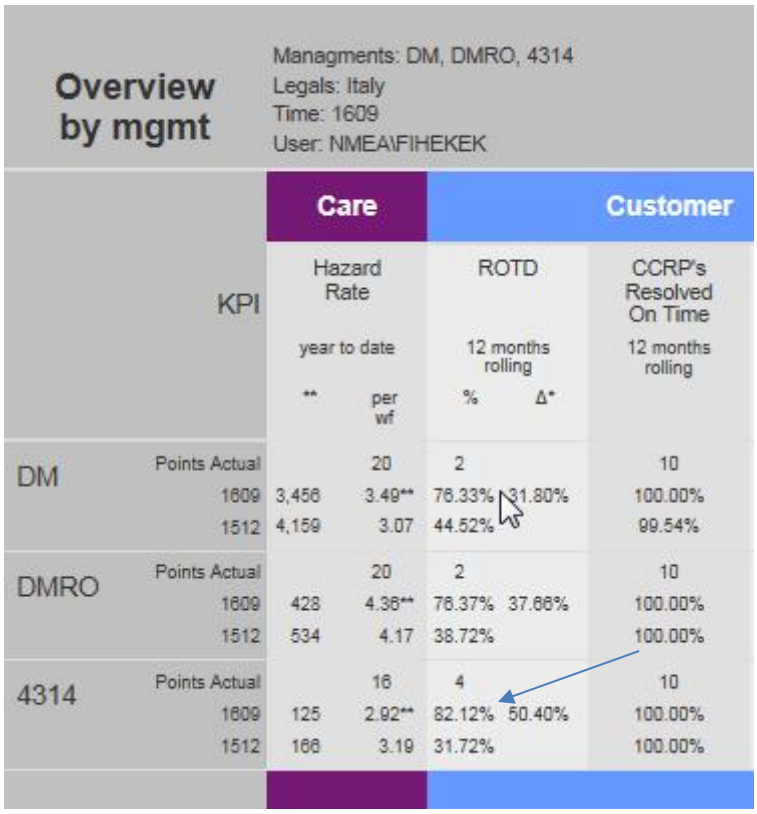
RelEx - Relentless Execution 2016

Overview by mgmt		4314 Robots & Applications (R&A), Italy, 1601						
		Care		Customer				
KPI		Hazard Rate		ROTD		CCRP's Resolved On Time	FFR	
		year to date		12 months rolling		12 months rolling	12 months rolling	
		**	per wf	%	Δ*		%COS	Δ*
4314	Points Actual		0	0		10		0
	1601	1	0.23**	34.3%	2.6%	100%	0.3%	0.0%
Robots & Applications (R&A)	1512	166	3.19	31.7%		100%	0.2%	
ITABB	1601	1	0.23**	34.3%	2.6%	100%	0.3%	0.0%
Sesto San Giovanni	1512	166	3.19	31.7%		100%	0.2%	

Figure 28, Baseline for ROTD January 2016 (ABB Relentless Execution Dashboard, Abacus Slim)

The project was done with a tight schedule, but in a secure and systematic manner by recognizing the phenomena at ABB, by defining the actual concretical issue, directing it to the right parts of organization and people and by executing few system related corrective actions. By improving the weak areas of the process and finally setting up the control points in order to keep the acceptable level it was possible to eliminate most of the waste in the process and by doing that add more value in the customer purchase.

Final result after improvement activities:



Overview by mgmt

Managments: DM, DMRO, 4314
Legals: Italy
Time: 1609
User: NMEA\FIHEKEK

KPI		Care				Customer
		Hazard Rate		ROTD		CCRP's Resolved On Time
		year to date		12 months rolling		12 months rolling
		**	per wf	%	Δ*	
DM	Points Actual		20	2		10
	1609	3,456	3.49**	76.33%	31.80%	100.00%
	1512	4,159	3.07	44.52%		99.54%
DMRO	Points Actual		20	2		10
	1609	428	4.36**	76.37%	37.66%	100.00%
	1512	534	4.17	38.72%		100.00%
4314	Points Actual		16	4		10
	1609	125	2.92**	82.12%	50.40%	100.00%
	1512	166	3.19	31.72%		100.00%

Figure 29, Results for ROTD September 2016 (ABB Relentless Execution Dashboard, Abacus Slim)

The success of the project is high in terms of better ROTD performance (Figure 28) and highly appreciated in ABB organization. At the end of September the PG 4314 ROTD procentage was as high as **82,12%.** Furthermore, the even greater advantage by doing this project is that ABB has the possiblity to **leverage** the same acitivity plan to other DMRO countries and even across ABB BU's. In this way, according to lean principle, a company can in a fast and systematic way improve the process and gain huge advantages. This study clearly shows that by using DMAIC protocol the weak parts of the process in question can be found and improved.

10 Conclusions and areas of Improvement

At the end of the project and comprehensive study on the components involved it can be noted that right things were done in different parts of the process to gain better request on time delivery performance for the DMRO PG 4314.

For even better results further analysis would be required to check the logic of each individual Robotic type. By doing this ABB could gain even better results and could launch smaller projects to tackle the same fundamental obstacles which were done in this study, but in the larger scale – on item category level only.

To do the same exercise on the *Robot type* it would be possible to find out the differences and the waste on minor scale, but would have a big influence on the overall ROTD performance.

Each *product line* in PG 4314 should do the similar kind of a lean exercise to see whether the initiator for the bad performance is at the front end (LSO), or the back bone (PU) of the process or both. This was not the scope of this study.

As a result of the study we can see the efforts were worth wile and accumulated the better performance in terms or ROTD for DMRO 4314. The process itself in such a big organization as ABB required a big effort from all counter parties but by following the WBS and lean protocol it was possible to do successfully. I am very proud of the whole project team and the commitment of the persons participating this ice breaking lean project. I am personally very satisfied with the improvement achievement in terms of ROTD percentage.

11 Abbreviations

PGU	Product Group Unit; unit of reporting within Opex Analyzer. A PGU is a combination of Local Product Group and a specific sales office location
LSU	Local Sales Unit
OTD	On-time delivery
ROTD	Request on-time delivery
OPEX Analyzer	ABB Group global reporting database
OMS	Order Management System; used mostly within DMDR, DMMG and minority within DMRO
PG	Product Group
LPG	Local product group
BU	Business Unit
LBU	Local Business Unit
DM	Discrete and Automation Motion Division
DMRO	Robotics Business Unit
DMDR	Drives Business Unit
DMMG	Motors and Generators Business Unit
DMPC	Power Conversion Business Unit
PU	Production unit (factory)
SU	Sales unit
DP	Delivery Performance
Gemba walk	Visual physical walk through a process
Mean	Mathematical average
Median	Middle value of a data set
Lean	Flexible, flat, fast, controllable, no waste
BB	Black Belt
Delce	ABB European Central Stock
ANOVA	Analysis of Variation

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